
This is a reproduction of a library book that was digitized by Google as part of an ongoing effort to preserve the information in books and make it universally accessible.

Google™ books

<https://books.google.com>



UC-NRLF



B 3 114 776

MANUAL OF SEAMANSHIP

VOL. II
1951



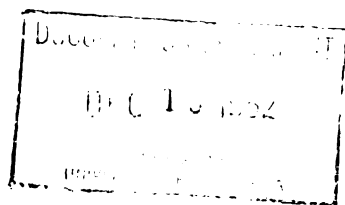
ADMIRALTY



Manual of Seamanship

Volume II

B.R. 67 (2/51)



LONDON : HER MAJESTY'S STATIONERY OFFICE

1952

Crown Copyright Reserved

PUBLISHED BY HER MAJESTY'S STATIONERY OFFICE

To be purchased from

York House, Kingsway, LONDON, W.C.2 423 Oxford Street, LONDON, W.1
P.O. Box 569, LONDON, S.E.1

13a Castle Street, EDINBURGH, 2	1 St. Andrew's Crescent, CARDIFF
39 King Street, MANCHESTER, 2	Tower Lane, BRISTOL, 1
2 Edmund Street, BIRMINGHAM, 3	80 Chichester Street, BELFAST

or from any Bookseller

1952

Price £1 0s. 0d. net

VK 541
G8
1951
v. 2

ADMIRALTY, S.W.1.
31st December, 1951.

B.R. 67(2/51), *Manual of Seamanship, Volume II*,
having been approved by My Lords Commissioners of
the Admiralty, is hereby promulgated for the information
and guidance of all concerned.

By Command of Their Lordships,

J. G. Lang

Preface

The *Manual of Seamanship* is divided into three volumes.

Volume I is intended to be used as a text book by Naval Cadets and Seaman Boys who are under training at shore establishments.

Volume II, herewith, is a continuation of Volume I, and with it is intended to be used as a text book by junior officers, Petty Officers, Leading Seamen, and by men desiring to qualify for advancement.

Both these volumes will also serve as books of reference for junior officers and senior ratings, and it is hoped that they will also prove useful and instructive to other professional seamen, yachtsmen, and all instructors of seamanship.

Lists of questions on the information given in each chapter have been included as an appendix to each of Volumes I and II, to give candidates for examination some idea of what they are expected to know and of the type of question they may be asked.

Volume III comprises information on the more advanced aspects of seamanship, and is intended as a book of reference for all seamen of experience.

Contents

CHAPTER I SHIP RECOGNITION

	<i>Page</i>
WARSHIPS—Recognition of types and classes—Recognition of national characteristics—Comparison between length and displacement ...	1
MERCHANT SHIPS—Identification at different ranges—General hints on ship recognition—Means of identification	14

CHAPTER II SHIP SAFETY

PRECAUTIONS AGAINST FLOODING—Water-tight compartmentation—Classification and identification of water-tight openings—Rules for opening and closing water-tight openings—Ventilating systems—Pumping and draining systems	27
PRECAUTIONS AGAINST GENERAL DAMAGE—Duplication and dispersal of machinery—Provision of damage control equipment—Duplication and dispersal of stores	33
PRECAUTIONS AGAINST CASUALTIES—Causes of, and precautions for avoiding—Precautions when opening unventilated compartments ...	33
RULES FOR SHIP SAFETY—General rules—Rules for maintenance of fittings and equipment	35
EMERGENCY STATIONS and ABANDONING SHIP	36

CHAPTER III FIRE-FIGHTING

FIRE PREVENTION—Inflammable matter, liquids and materials—Explosives and fireworks—Heat—Spontaneous combustion—Oxygen ...	38
PRINCIPLES OF FIRE-FIGHTING—Starving, cooling and smothering—Reignition—Smoke—Protective clothing and cover—Cooling adjacent compartments	41
PORTABLE AND MOBILE FIRE FIGHTING APPLIANCES—Hand extinguishers—Foam and CO ₂ mobile units—Portable pumps	44
FIRE-FIGHTING INSTALLATIONS—Firemain system—Flooding—Magazine and hangar spraying—Steam, foam, and methyl bromide systems ...	49
AUXILIARY FIRE-FIGHTING EQUIPMENT—Lighting, sand, protective clothing and breathing apparatuses	54
METHODS OF EXTINGUISHING FIRES—Structural and general fires—Magazine and shell room fires—Inflammable liquid fires—Electrical fires—Cinema film fires	56

CONTENTS

CHAPTER IV

INTERNAL ORGANISATION

	<i>Page</i>
VOICE COMMUNICATION—General rules—Different methods and how to use them	58
ORGANISATION—Allocation of hands for routine and special work—Quarters—Watch and station bill—Duty watches, watch roster and watch duties—Evolutions, and station bill—Petty officers duties—Special dutymen, special parties and watch-keepers—Berthing—Offices—Daily orders... ..	63
MESSING—Different methods of messing	80
PROVISIONS—Issues—Stocks—Packing	82
NAVAL STORES—Classification—Issue and return... ..	83
STOWAGE OF STORES AND PROVISIONS—Inflammable liquids—other special stowage requirements—Preparing for provisioning	84

CHAPTER V

ROPE AND ITS USAGE

SEIZINGS—Types of—Strengths—How to pass	87
ADVANCED SPLICING OF CORDAGE—Long splice—Cut splice—Chain splice—Flemish eye—Grommet—Fitting a becket	92
WORMING, PARCELLING AND SERVING	97
KNOTS AND GENERAL ADVANCED WORK IN CORDAGE—Different types of knot, and how to make them—Coverings—Net making	98
SPLICING WIRE ROPE—Splices—Strops and eyes—Splicing cordage into wire rope—Seizings and servings	112
HAWSERS—Handling of hawsers—Stoppers and stoppering—Berthing hawsers—Fitting, supply, and maintenance of hawsers	123
GENERAL REMARKS ON CORDAGE—Types and characteristics—Special kinds—Manufacture—Specifications, inspecting and testing	137
GENERAL REMARKS ON WIRE ROPE—Special types—Terminals—Flexibility—Factor of safety—Sheaves for wire rope—Maintenance—Inspection and testing	145
TABLES OF CORDAGE AND WIRE ROPE giving sizes, weights, breaking stresses and other details	154

CONTENTS

CHAPTER VI

RIGGING

	<i>Page</i>
MISCELLANEOUS RIGGING—The <i>Rigging Warrant</i> —Dressing lines—Guardrails—Rattling down—Sending down and crossing yards—Striking and housing topmasts—Boat booms—Accommodation and gangway ladders—Fenders and stages—Repairing a spar	167
AWNINGS—Awnings, awning curtains, and side screens—Spreading and furling awnings—Care and maintenance of awnings	182
SAILMAKING—Canvas—Sailmaker's tools—Sewing and repairing canvas—Roping—Splices—Grommets, cringles and eyelets	188
DERRICKS, WINCHES AND CRANES—Rigs—Methods of working—Testing	197
SLINGING	205
EXTEMPORE DERRICKS, SHEERS AND GYNS—General description—Rigging of	210
STRENGTHS OF RIGGING FITTINGS AND GEAR—Explanation of "working load", "fatigue" and "factor of safety"—Classification and description of rigging fittings—Blocks, tackles and special purchases ...	220
GEARED BLOCKS—Uses and advantages of—Different types	229
ESTIMATION OF STRESSES—Principles of the "triangle of forces", and its application to estimating the stresses in derricks—Examples of how stresses in a derrick may be modified by altering the rig—Precautions	234

CHAPTER VII

BOATWORK

INSTRUCTION IN BOAT PULLING—Initial training—Hints to instructors	241
HINTS TO COXSWAINS	245
STOWAGE OF BOATS—Crutches and davits, their use and fittings—Reeving, fitting, and maintenance of boats' falls	249
SLINGING, LOWERING AND HOISTING BOATS—Slings and disengaging gear—Lowering and hoisting boats at davits in harbour—Lowering and hoisting a seaboat—Hoisting a swamped boat—Hoisting boom boats in and out	255
SEABOATS—Securing for sea—Hints to coxswains	268
SERVICE SAILING BOATS—Rigs and sail drills for the 27-ft. whaler, and 32-ft. cutter—Descriptions of the 27-ft. surf boat, and 14-ft. sailing dinghy	271
BOAT SAILING—Terms used in—Action of wind on sails—Pivoting point—Centre of effort of sail area—Use of rudder—Trim of boat—Set of sails—Trimming sails—Beating, going about, reaching, running and wearing—Rough weather—Effect and use of drop keel—Getting under way and coming alongside—Man overboard—Heaving to—Riding to a sea anchor	281
BOATS' SAILS—Care of—Bending of to a spar—Marking—Measurement of	296

CONTENTS

CHAPTER VII—*cont.*

	<i>Page</i>
POWER BOATS—Handling generally—Handling round-bilge boats— Handling hard-chine boats—Handling and maintenance of boats' engines	299
SPECIAL BOAT OPERATIONS—Towing—Beaching—Handling boats in surf—Landing on a rocky shore—Boarding at sea—Boarding a wreck—Recovering torpedoes—Sweeping—Diving—Arming boats	317
REPAIR OF BOATS	341
BUOYANCY OF BOATS—Testing for buoyancy—Estimation of buoyancy of boats, and of drums and casks	343
SUPPLY, FITTING OUT, DETAILS AND CARRYING CAPACITIES OF SERVICE BOATS	345

CHAPTER VIII

LIFE-SAVING APPLIANCES, AND ROCKET LIFE-SAVING APPARATUS

LIFE-SAVING APPLIANCES—Classification—Specification and survey— Marking—Stowage, and equipment—Life-jackets and buoyant suits— Life-buoys—Buoyant apparatus, including life-floats and inflatable life-rafts—Life-boats—Miscellaneous life-saving equipment ...	353
ROCKET LIFE-SAVING APPARATUS—Life-saving stations—Description and method of operation—Signals for operating	372

CHAPTER IX

ANCHORS AND CABLES, AND ANCHOR WORK

ANCHORS AND CABLES—Types of anchor—Chain cable and its compo- nents—Cable lockers—Cable gear and fittings—Capstans, cable holders and windlasses—Maintenance, survey and testing of anchors and cables—Tables of anchors and cables supplied to H.M. ships ...	374
ANCHOR WORK—Terms used in—Anchoring—Shortening in and weighing—Clearing foul anchor—Precautions in bad weather— Mooring and unmooring—Clearing a foul hawse—Securing to a buoy—Securing head and stern to buoys—Slipping from a buoy— Weighing by deck tackle—Pointing ship—Slipping by the stern from a buoy	400

CHAPTER X

LAYING OUT HAWSERS AND ANCHORS, TOWING, AND TARGET WORK

LAYING OUT HAWSERS AND ANCHORS	415
TOWING AND TAKING IN TOW—Towing hawsers—Towing arrangements— Taking in tow—Being towed—Slipping and recovering the tow ...	420
TARGET WORK—Types of target, and how they are handled and towed	425

CONTENTS

CHAPTER XI

PARAVANES AND MINESWEEPING

	<i>Page</i>
PARAVANES—The mine—The paravane—Typical rig for streaming and recovering P.V's—Streaming, recovering and running P.V's—Other rigs	433
MINESWEEPING—Types of mine—"Influence" and "Moored" mine-sweeping—Types of sweep—the "A" sweep, the "Oropesa" or "O" sweep, and the "Two-speed Sweep"—Dan buoys	441

CHAPTER XII

REPLENISHMENT AT SEA

METHODS OF REPLENISHMENT—Transfer of solids—Transfer of liquids—General requirements	454
RIGS FOR TRANSFER OF SOLIDS AND THEIR OPERATION—Light jackstay rig—Heavy jackstay rig	459
TRANSFER OF FUEL—Fuelling abeam, warship to warship—Fuelling abeam from a tanker, by derrick and by jackstay rig—Fuelling astern from a tanker—Fuelling astern from a warship	463

CHAPTER XIII

AIRCRAFT

Types of—Structural details—Stowage—Manoeuvring, slinging and transporting—Attending on and towing seaplanes—Rescuing aircraft crashed in the sea	474
--	-----

CHAPTER XIV

NOTES ON DAMAGE CONTROL AND SHIP STABILITY

DAMAGE CONTROL—Organisation—States of readiness—Water-tight conditions—"W/T Board" and "Integrity Log"—Identification markings—Equipment—Water-tight tests—Marking of pipes—Shoring	483
ELEMENTARY SHIP STABILITY—Flotation—Buoyant volume—Centres of gravity and buoyancy—Conditions for equilibrium, righting moment and righting lever—Heel, list and trim—Effects of loading, list, ballast and topweight—Effect of flooding and methods of countering—Correction of list—Loll—Effects of heel and trim on fighting efficiency	495

CHAPTER XV

SHIP MAINTENANCE

PAINT AND PAINTING—Paint coats and paint schemes—Composition and types of paint—Mixing paint—Preparation of a surface for painting—Painting generally—Brush and spray painting—Painting the ship's bottom	506
GENERAL SHIP MAINTENANCE—Maintenance of equipment and fittings—Cleaning ship	517

CONTENTS

CHAPTER XVI

NAVAL COMMUNICATIONS

	<i>Page</i>
FLAG SIGNALLING—Terms used—Positions of hoists and order of reading—Symbols used to represent flags and pennants—How to make, answer, and execute, a signal—Callsigns—Signals displayed when working cables— <i>Minor Landing Craft and Boat's Signal Book</i> —International Code—Equipment	522
SIGNALLING PROCEDURE—Procedure signs and phrases—Voice procedure—Flashing procedure—Semaphore procedure	531
ORIGINATING AND DRAFTING MESSAGES	538
COMMUNICATIONS DEPARTMENT—ORGANISATION	540
MESSAGE HANDLING AND DISTRIBUTION	541
AUTHORISED ABBREVIATIONS	542

CHAPTER XVII

CEREMONIAL

Wearing of Colours—Dressing Ship—Wearing of distinguishing flags—Flag and Senior Officers' distinguishing lights—Piping the side—Gun salutes—Morning and evening gun—Court Martial gun—Military honours, and guards and bands—Ceremonial reception—Salutes between ships—Ceremonial in boats—Salutes and marks of respect in boats—Boat hails—Wearing of standards or flags in vehicles ...	545
---	-----

CHAPTER XVIII

RULE OF THE ROAD, 1910 REGULATIONS

(For 1948 Regulations, see Appendix IV)

Explanation of the <i>International Regulations for Preventing Collisions at Sea (1910)</i> —Principles of the Steering and Sailing Rules	560
Extracts from the <i>International Regulations for Preventing Collisions at Sea</i> —Remarks on Steering and Sailing Rules—Remarks on sound signals for vessels in sight of one another	565
Navigation lights—Rules concerning daymarks and lights—Sound signals for use in low visibility—Other sound signals—Distress signals—Special signals	571
Lights and daymarks displayed by vessels, and their fog signals ...	578

CHAPTER XIX

CONNING AND STEERING

Compasses—Conning communications and instruments—Precautions before proceeding to sea—Sirens—Special sea dutymen—Alternative conning and steering positions—Steering gear in H.M. ships—Precautions while steering	583
---	-----

CONTENTS

CHAPTER XX

SHIPS' COMPASSES AND DIRECTION BY COMPASS

	<i>Page</i>
The gyro-compass—Magnetism, and direction by magnetic compass— Variation and deviation—Conversion of compass and magnetic directions to true directions—Compass equipment—Supply and maintenance of compasses	595

CHAPTER XXI

MEASUREMENT OF SPEED AND DISTANCE

Sea measurement—Dutchman's log—Hand log—Estimation of speed by revolutions—Towed logs—Chernikeef log—Pitometer log—Dis- tance meters	608
---	-----

CHAPTER XXII

SOUNDING

SOUNDING BY MACHINE—Equipment for—How to take soundings ...	620
ECHO SOUNDING—Principle of—Equipment for—Echo-sounder, Type 765	627

CHAPTER XXIII

LATITUDE AND LONGITUDE, CHARTS AND HYDROGRAPHIC PUBLICATIONS

LATITUDE AND LONGITUDE—Parallels of latitude, and meridians— Latitude and longitude—Position—Linear measurement of latitude and longitude—The great circle and the rhumb line	632
MAPPING—Mercator's projection—Gnomonic projection	635
ADMIRALTY CHARTS AND HYDROGRAPHIC PUBLICATIONS—Types, publi- cation, issue, indexing and grouping of charts— <i>Notices to Mariners</i> and correction of charts—Other hydrographic publications	639

CHAPTER XXIV

TIDES AND TIDAL STREAMS

TIDES—Cause of—The tide wave—Springs and neaps—Local tides— Effects of weather on tides—Interval between tides—Ebb and flood, range and stand—Grounding—Tidal definitions—Tidal information on charts— <i>Admiralty Tide Tables</i>	649
TIDAL STREAMS—Description, definitions and behaviour—Sources of information on tidal streams and currents—Indication of tidal streams and currents on charts—How to forecast a tidal stream from information on a chart	660

CONTENTS

CHAPTER XXV

INTRODUCTION TO PILOTAGE

	<i>Page</i>
CHARTWORK —Plotting a position by latitude and longitude, and by bearing and distance—Laying-off and taking-off courses and bearings—Recording a ship's position—Transferring a position from one chart to another—Plotting the ship's track—Shaping a course, and reaching a position, allowing for a tidal stream—Position lines—Transits, and checking deviation and compass error by transits—Leading marks and clearing marks—Position lines and fixes—Approximate position by bearing and horizon range of a light—Distance by siren echo	665
REMARKS ON PILOTAGE —Preparation for a passage—Care and use of charts—Coasting—Fog and thick weather—Pilotage in narrow waters—The <i>Ship's Log</i>	683

CHAPTER XXVI

THE SOLAR SYSTEM: TIME: THE STARS

THE EARTH AND THE SUN —Earth's orbit around the Sun—Seasons—Climate—Daylight, sunrise, sunset, and twilight—The <i>Abridged Nautical Almanac</i>	690
TIME —The day, the month, and the year—Longitude and time—Local mean time and Greenwich mean time—The date—Zone time—Standard time—To find the times of sunrise, sunset, and twilight—Chronometers, watches and clocks—Time kept in H.M. ships ...	696
THE MOON —The Moon's orbit—Phases of the Moon—Appearance and attitude of the Moon—Moonrise and moonset	707
THE PLANETS AND STARS —Planets—Stars—The celestial sphere—Appearance of the night sky—Naming and grouping of stars—Star map, and how to use it—Stars indicating the cardinal points of the compass	709

CHAPTER XXVII

THE WEATHER AND METEOROLOGICAL INSTRUMENTS

THE WEATHER —The atmosphere—Wind, and Beaufort wind scale—Other elements—Pressure systems—Local forecasting—Climate—Oceanic winds—Tropical storms—Local winds—Climatic zones ...	716
METEOROLOGICAL INSTRUMENTS —Mercurial barometer—Aneroid barometer—Barograph—Thermometer—Hygrometer	730

CONTENTS

Page

APPENDIX I

GLOSSARY OF TERMS AND EXPRESSIONS USED BY SEAMEN	737
---	-----

APPENDIX II

RIGGING NOTES AND GENERAL DATA

RIGGING NOTES—Strength of ropes—Relative sizes of sheaves and bollards required for ropes—Factors of safety for lifting appliances—Data for blocks and tackles rove with cordage—Safe loads for common fittings—Data for sheers—Buoyancy of casks	759
GENERAL DATA—British weights and measures—Comparisons between British and metric systems of weights and measures—Conversion factors for various measures and weights—Roman numerals—Rate of travel and range of sound	762

APPENDIX III

QUESTIONS

Questions on the text of each chapter, typical of those which may be asked of candidates for examination	771
---	-----

APPENDIX IV

RULE OF THE ROAD, 1948 REGULATIONS

(For 1910 Regulations, see Chapter XVIII)

Explanation of the <i>International Regulations for Preventing Collisions at Sea (1948)</i> —Principles of the Steering and Sailing Rules	807
Extracts from the <i>International Regulations for Preventing Collisions at Sea (1948)</i> —Remarks on the Steering and Sailing Rules—Remarks on sound signals for vessels in sight of one another	811
Navigation lights—Rules concerning daymarks and lights—Sound signals for use in low visibility—Other sound signals—Distress signals—Special signals	819

INDEX	831
--------------	-----

CHAPTER I

Ship Recognition

A SEAMAN of the Royal Navy should be able to identify the type and probable nationality of any warship he sees ; and, with experience, he should also be able to assess her offensive power and speed with a good degree of accuracy. In addition, he should be able to identify the type of a merchant vessel and make a good guess as to her nationality, ports of call, route, destination, carrying capacity and nature of her cargo.

As this ability can only be gained by learning the " hall mark " and outstanding features of each type and then frequently practising their identification, he should take every opportunity of testing his powers of such observation and deduction.

WARSHIPS

Instantaneous recognition of type is obtained from a system of " hallmarks " which shows the outline of each type of ship as she appears when seen at a distance or in low visibility, and the outline plan of her hull as seen from the air. Recognition of class is obtained by identifying the principal features of a particular ship. It may also be possible to determine the nationality of a warship by recognising certain characteristics which may be peculiar to ships of a particular country. The hallmarks and principal features of each type of warship are described and illustrated below ; national characteristics of certain warships of this and other countries follow.

Recognition of Type

Warships are classified for recognition purposes as follows :—

- (i) battleships ;
- (ii) aircraft carriers (fleet and light fleet carriers) ;
- (iii) cruisers (heavy and light) ;
- (iv) destroyers ;
- (v) frigates ;
- (vi) coastal craft (trawlers, gunboats, etc.)
- (vii) landing craft.

BATTLESHIPS

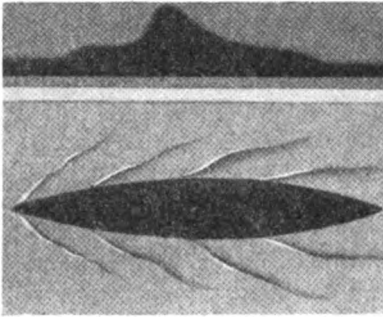
Hallmarks

Fig. 1

- (i) Long forecastle and quarterdeck.
- (ii) Low freeboard and apparently flush deck.
- (iii) High, massive superstructure rising like a steep hillock.
- (iv) Broad beam (one sixth to one eighth of the ship's length) and conspicuous broad bow wave.



Fig. 2

Principal Features

- (i) Never more than two funnels. Funnel or funnels vertical (except in some ships where the upper part is raked aft).
- (ii) Conspicuous gun turrets before and abaft central pyramid.
- (iii) Always two masts, usually of tripod structure and supporting radar and control platforms.
- (iv) Considerable top hamper amidships, around the funnels.

CARRIERS

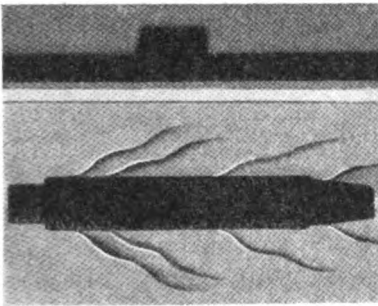
Hallmarks

Fig. 3

- (i) High freeboard and flush deck.
- (ii) Squat and compact island superstructure amidships.
- (iii) Flight deck shaped like a tally plate.
- (iv) Island superstructure amidships on starboard side.
- (v) Usually conspicuous wake.



(i) FLEET CARRIER



(ii) LIGHT FLEET CARRIER

Fig. 4

Principal Features

- (i) Island superstructure about one sixth of the ship's length.
- (ii) Island broad and squat.
- (iii) Wireless aerial masts along both sides, lowered outboard when flying is in progress.
- (iv) Flight deck rounded down at bow and stern.
- (v) At any but very close range fleet and light fleet carriers are indistinguishable, being approximately of similar dimensions and profile. These types can be recognised by minor differences in equipment, *e.g.* position of crane at after end of island, or hinged W/T masts on port side only in some light fleet carriers.

CRUISERS

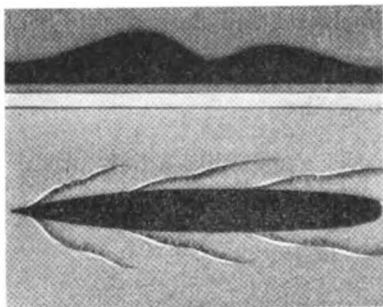
Hallmarks

Fig. 5

- (i) Two low humps, the foremost larger than the after.
- (ii) Low freeboard and apparently flush decked, with the deck sloping slightly downward from forward to aft.
- (iii) Narrow beam and comparative absence of wash and wake.



Fig. 6

Principal Features

- (i) From one to three funnels, usually raked but sometimes vertical. A single funnel, or sometimes the foremost of two, broad, trunked and combined.
- (ii) Light tripod masts, usually conspicuous. The mainmast is sometimes a pole mast.
- (iii) Crane or derrick usually visible amidships, but the former is sometimes right aft.
- (iv) Turrets conspicuous.
- (v) Forecastle deck higher than quarterdeck and extending three-quarters of the length of the ship.
- (vi) Comparatively short forecastle before foremost turret, and short quarterdeck abaft aftermost turret.

DESTROYERS

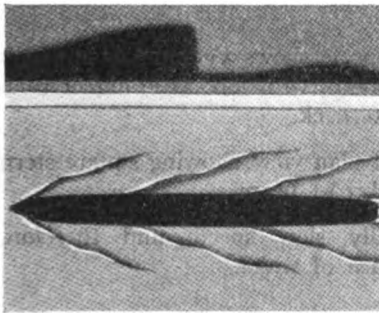
Hallmarks

Fig. 7

- (i) Overall low silhouette merging easily into background.
- (ii) Wedge-shaped silhouette forward, otherwise low-lying, with slightly rounded rise aft.
- (iii) When seen from the air, outline of hull resembles a cigar with its stub end aft.
- (iv) Usually very conspicuous wake.



Fig. 8

Principal Features.

- (i) Forecastle deck extends for one-third of the ship's length, with the bridge superstructure at its after end.
- (ii) Light tripod or lattice foremast, and light pole mast aft.
- (iii) One or two conspicuous funnels, usually squat and raked, but occasionally narrow and upright.
- (iv) Small gun houses or gun shields with single or twin guns.
- (v) Torpedo tubes, inconspicuous and mounted close to the deck amidships.
- (vi) Depth charge or sweeping gear right aft.

FRIGATES

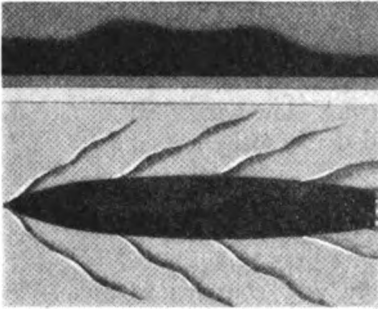
Hallmarks

Fig. 9

- (i) Silhouette shows a comparatively high freeboard, with forecastle higher than quarterdeck.
- (ii) Short plan view, showing square stern and broad beam.
- (iii) Usually slow speed, and therefore absence of wake.

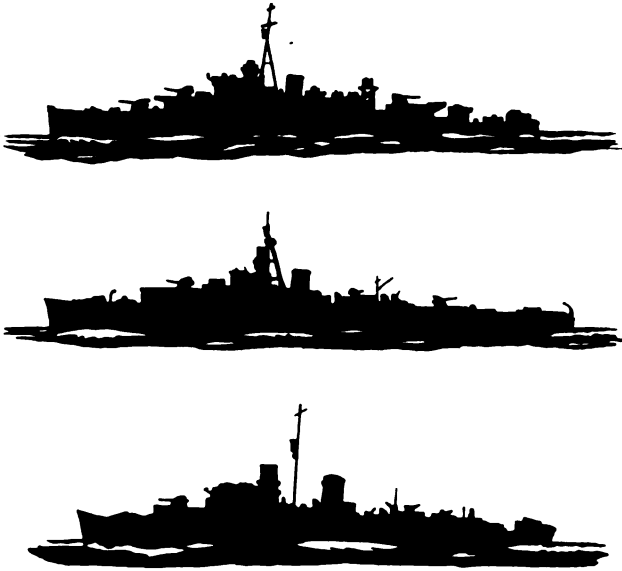


Fig. 10

Principal Features

- (i) Box bridge and single funnel.
- (ii) Funnel nearly midway between bow and stern.
- (iii) Light pole, tripod or lattice mast forward, and sometimes a light pole mast aft.
- (iv) Guns inconspicuous.
- (v) Short forecastle and quarterdeck, the latter cluttered with depth charge or sweeping gear.

COASTAL CRAFT

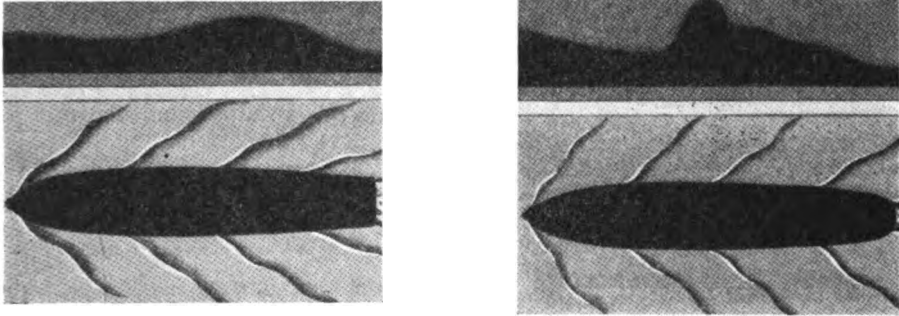
Hallmarks

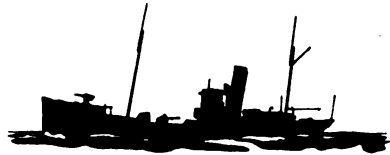
Fig. 11

(i) In motor gunboats and motor torpedo boats: flattish top line for three-quarters of length, rising slightly amidships and falling away aft.

(ii) In trawlers: high bow, low stern; rise amidships is steep.



(i) M.T.B.



(ii) TRAWLER

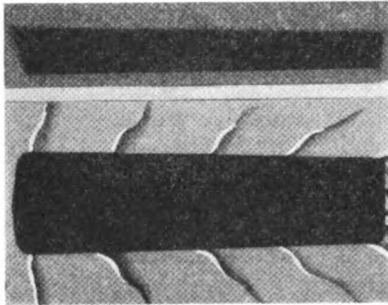
Fig. 12

Principal Features

At high speeds, fast coastal craft are almost hidden in spray, and unless viewed very closely are therefore difficult to classify.

Trawlers can be distinguished by their high bows, pronounced sheer, high single funnel, and high narrow bridge.

LANDING CRAFT

Hallmarks

Rectangular, box-shaped and flat-topped silhouette.

Fig. 13



(i) LANDING CRAFT—PERSONNEL



(ii) LANDING CRAFT—MECHANISED



(iii) LANDING CRAFT—TANK

Fig. 14

Principal Features

- (i) Blunt and raking or spoon-shaped bows.
- (ii) Square and raking or spoon-shaped sterns.
- (iii) Flattened upper deck, usually with little superstructure.
- (iv) Comparatively high freeboard.
- (v) Exaggerated bow wave from bluff bows.

National Characteristics and Identity

The nationality of a warship is difficult to distinguish at long ranges. At medium ranges the general appearance of the hull, funnels, masts and superstructure, backed up by certain distinctive features such as the position of turrets, cranes and catapults, the size and shape of the bridge superstructure, the shape of the bow and stern, and the types of radar aerials, will usually afford clues to the country of origin.

SHAPE OF BOW AND STERN

In warships the different shapes of bow and stern are usually limited to the following examples :—

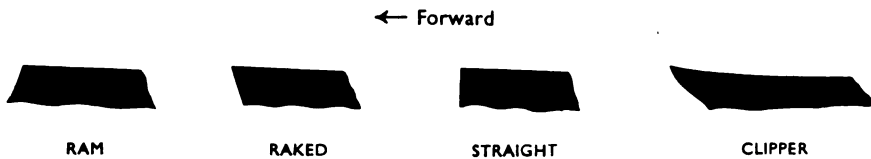


Fig. 15.—Shapes of bows of warships



Fig. 16.—Shapes of sterns of warships

COMPARISON OF GENERAL FEATURES

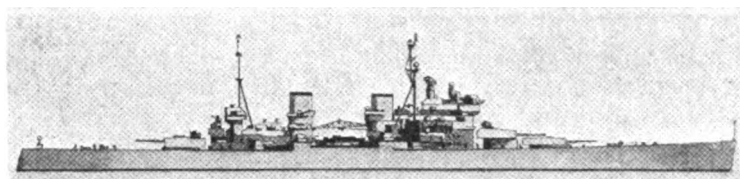
Sketches of various types of warship of different nationalities are reproduced in Fig. 17 so that their salient features may be compared. To enable the features of the smaller ships to be recognised, they are not drawn to the same scale.

CLASS

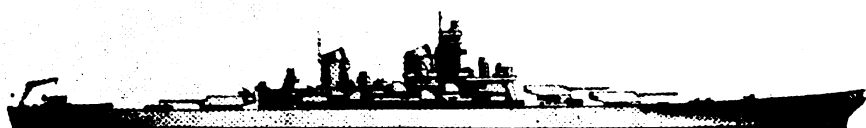
The class of a warship, *e.g.* a Colony Class cruiser, a Battle Class destroyer, etc., can be identified by the position and grouping of features such as guns, torpedo tubes, funnels, bridges, and masts. The features of many classes can be memorised, and they can be checked by reference to the various books supplied for this purpose. These are : *Jane's Fighting Ships*, and BR 642 *Summary of Warships* (of different nations).

IDENTITY

This can be done with certainty only by noting small details such as the height of topmasts, details of radar and wireless aerials, and siting of gaffs. Such details can be checked by reference to the recognition books already mentioned.



(i) BRITISH BATTLESHIP



(ii) AMERICAN BATTLESHIP



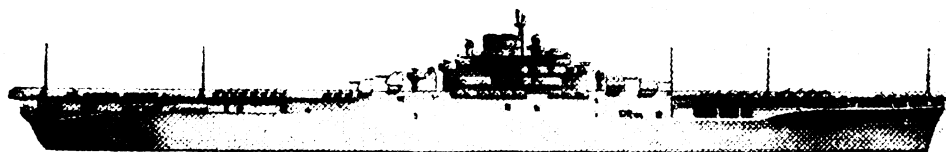
(iii) AMERICAN BATTLESHIP



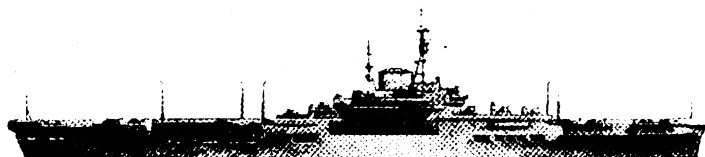
(iv) RUSSIAN BATTLESHIP



(v) FRENCH BATTLESHIP



(vi) AMERICAN AIRCRAFT CARRIER

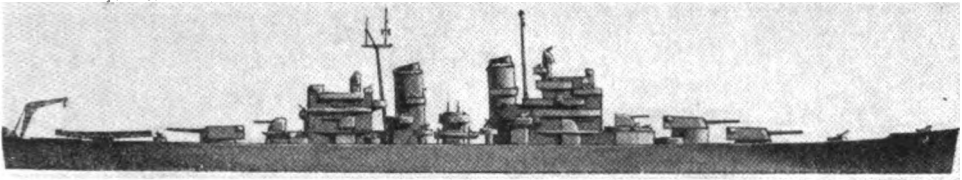


(vii) BRITISH AIRCRAFT CARRIER

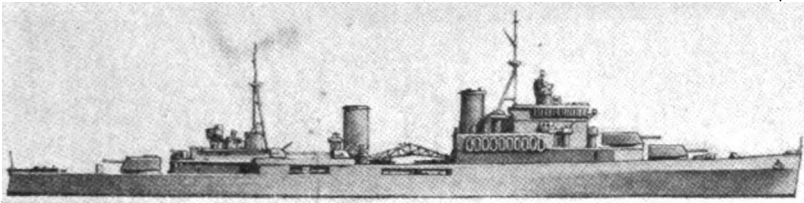
Fig. 17.—Types of warships of various nationalities



(viii) RUSSIAN CRUISER



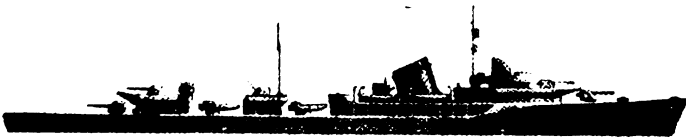
(ix) AMERICAN CRUISER



(x) BRITISH CRUISER



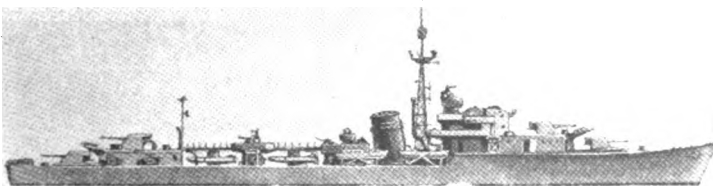
(xi) FRENCH CRUISER



(xii) RUSSIAN DESTROYER



(xiii) AMERICAN DESTROYER



(xiv) BRITISH DESTROYER

Fig. 17 (contd.)—Types of warships of various nationalities

Comparison between Length and Displacement of Warships

This can only be a very approximate comparison because the displacement of warships of about the same length but having different armour, armament and speed may vary greatly.



(i) IOWA (U.S.A.) 52,000 TONS, 887 FEET



(ii) KING GEORGE V (BRITISH) 44,650 TONS, 745 FEET



(iii) MIDWAY (U.S.A.) 55,000 TONS, 986 FEET



(iv) COLOSSUS (BRITISH) 17,720 TONS, 694 FEET

Fig. 18.—Length : Tonnage—comparison of warships



(v) CHICAGO (U.S.A.) 16,000 TONS, 673 FEET



(vi) NEWFOUNDLAND (BRITISH) 8,000 TONS, 555 FEET



(vii) ROYALIST (BRITISH) 5,770 TONS, 512 FEET



(viii) GEARING (U.S.A.) 2,400 TONS, 390 FEET



(ix) HUNT CLASS (BRITISH)
1,500 TONS, 296 FEET



(x) RIVER CLASS (BRITISH)
1,350 TONS, 300 FEET



(xi) TRAWLER (BRITISH)
450 TONS, 150 FEET

Fig. 18. (contd.)—Length : Tonnage—comparison of warships

MERCHANT SHIPS

Classification and identification of merchant ships is more difficult than that of warships, because not only are the types of the former more numerous, but ships of the same type may embody salient features of several other types. Again, ships remarkably similar in outward appearance may belong to quite different types (*e.g.* the tanker and the ore freighter). For these reasons, recognition of merchantmen involves a methodical and detailed system which is designed to assist positive identification on the spot, or later identification from reports based on a recognition code.

The system adopted is designed for observation at "Long", "Medium" and "Close" ranges, the identification details being noted progressively at each stage from a broadside viewpoint.

Identification at Long Range

SMOKE

The appearance of smoke on the horizon may be the first indication of a merchant vessel, but it should be remembered that a merchantman does not always make smoke. Coal-fired ships usually make smoke, the smoke being most evident in ships with hand-fired furnaces and especially shortly after the watches are changed. Oil-fired ships normally do not make smoke, but it occurs occasionally when the mixture of fuel and air in the funnels is incorrect. Motor ships seldom make smoke, except for a small wisp which soon dissipates.

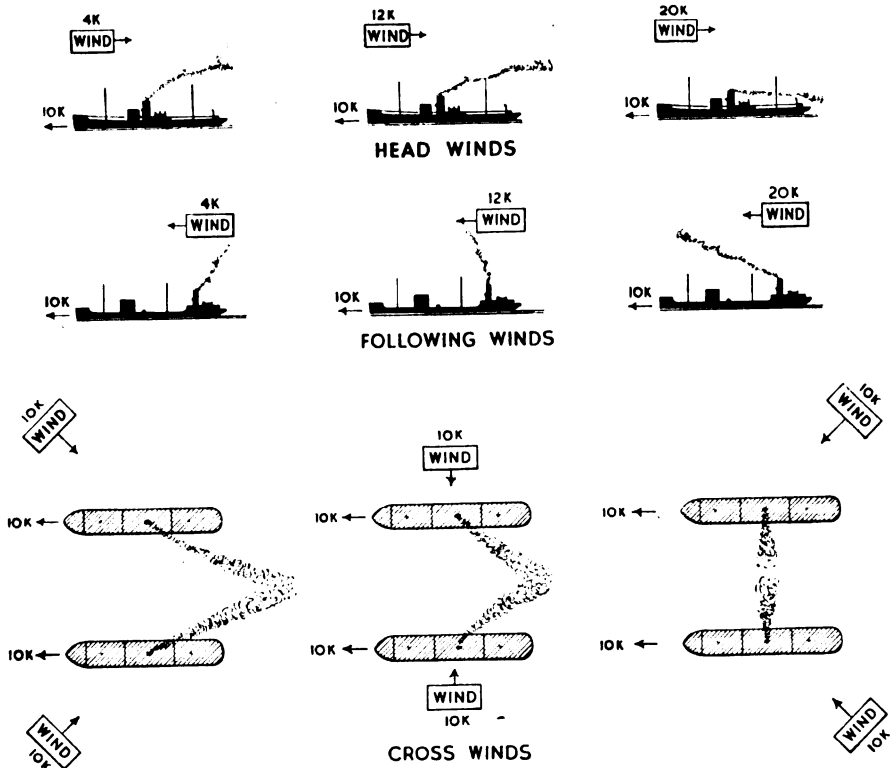


Fig. 19.—Effects of wind on funnel smoke

Funnel smoke is an unreliable guide to the direction in which a ship is moving and should not be used for estimating her speed. Fig. 19 shows the effects of wind on funnel smoke.

MASTS, FUNNELS, SUPERSTRUCTURE AND KINGPOSTS

These will be the first recognisable features to appear over the horizon. Their appearance then may afford the only opportunity for recognition, and they should be noted in their order from forward aft, in their relative position to each other.



BULK FREIGHTER



FREIGHTER



LINER

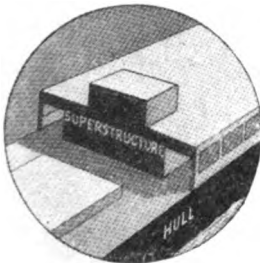


CARGO-LINER

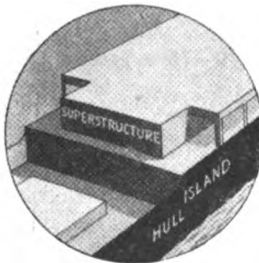
Fig. 20.—Appearance of merchant ships on the horizon

HULL FORM

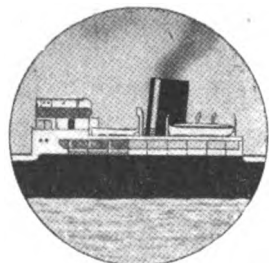
The hull may be flush-decked or raised into forecastle, midcastle and poop. *These are integral parts of the hull, called "islands", and must not be confused with superstructures, upperworks and deck houses.*



**FLUSH-DECKED HULL
AND SUPERSTRUCTURE**



**ISLAND HULL
AND SUPERSTRUCTURE**



**MID-CASTLE, ISLAND HULL
AND SUPERSTRUCTURE**

Fig. 21.—Hull and superstructure

The seven basic forms of hull shown in Fig. 22 are distinguished from each other by allocating the numbers 1, 2 and 3 to their forecastle, midcastle, and poop respectively. Thus the middle hull of the second row would be classified as a "1-3 hull".

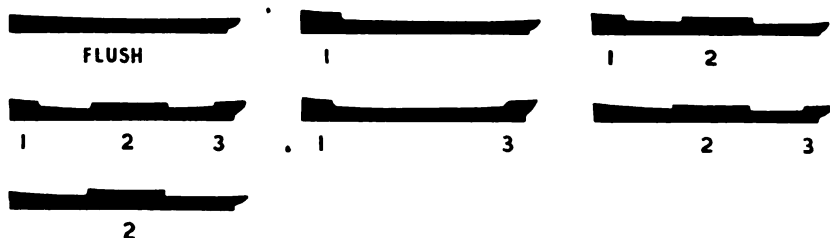


Fig. 22.—The seven basic forms of hull

Identification at Medium Range

At sea few opportunities will occur for identifying ships from close ranges, and observation must therefore be thorough, as many features as possible being identified and noted methodically.



Fig. 23.—View of freighter at medium range

Features should be identified in the following order: (i) bow; (ii) stern; (iii) funnels; (iv) profile; (v) positions of masts; (vi) positions of kingposts; (vii) length of vessel; (viii) estimated gross tonnage.

Bows

The three distinctive types of bow are shown in Fig. 24.

← Forward



Fig. 24.—Three types of bows

STERNS

The four types of sterns are classified as shown in Fig. 25.

Aft →



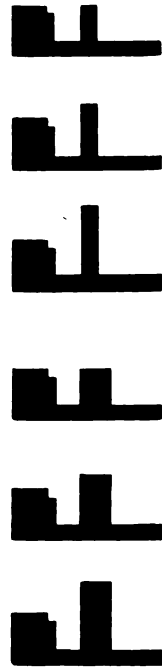
Fig. 25.—Four types of sterns

FUNNELS

There are two classes of funnels, "narrow" and "broad", as shown in Fig. 26(i). The length of the funnel is gauged from the height of the bridge, a short funnel being about the same height as the top of the bridge. In ships with a long, high superstructure, built around the funnel (see Fig. 26 (ii)), the height of the funnel is judged by the distance it projects above that superstructure.



(ii)



(i)

Fig. 26.—Types of funnel

PROFILES

For purposes of recognition the positions of the bridge superstructure and funnel in relation to each other and to the hull are known as the "profile".

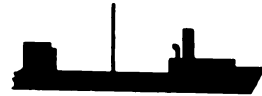
Profiles are classified as follows : (i) split, (ii) composite, and (iii) funnel-aft. Examples are shown in Fig. 27.



SPLIT



COMPOSITE



FUNNEL-AFT

Fig. 27.—Profiles

MASTS

There are three main types of mast : (i) pole, (ii) crosstree, and (iii) goal-post.

Pole masts are of single construction, often raked, and usually found in liners.

Crosstree masts consist of a heavy lower-mast, stepped vertically, with crosstrees at its head for supporting derricks, above which is stepped a light pole mast.

Goalpost masts consist of two heavy lowermasts, stepped vertically athwartships and connected with a latticework structure on the top of which is stepped a light pole mast. They should not be confused with "twin kingposts", which are described in the next paragraph.

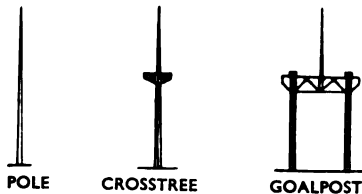


Fig. 28.—Types of masts

KINGPOSTS

These are very similar to lowermasts but usually shorter. They are stepped vertically, either singly or in pairs athwartships, and in the vicinity of hatchways out of reach of the mast derricks. Two kingposts connected by lattice or frame work are known as "twin kingposts". A kingpost, being of hollow construction, is sometimes fitted with a cowl at its head and then serves the double purpose of a support for a derrick and a ventilator.

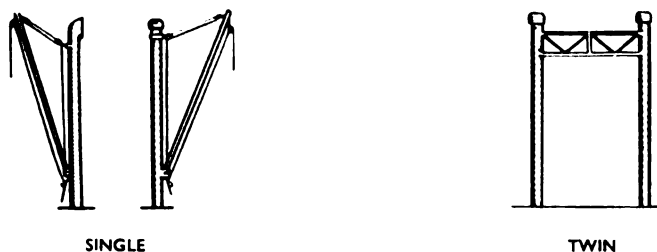


Fig. 29.—Types of kingposts

LOCATION OF FEATURES

The foregoing features having been identified the next step is to note their positions in relation to the hull. For this purpose the hull is divided into 12 equal parts, and numbered from stem to stern (see Fig. 30); the position of each feature can then be noted with considerable accuracy. This method of reporting enables a remarkably accurate sketch to be made by a person who may never have seen the ship in question, and may enable a ship to be identified from a signalled report.

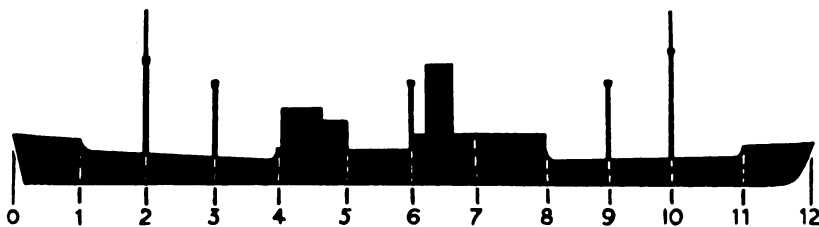


Fig. 30.—Sub-division of hull for locating features

LENGTH ESTIMATION

Neither the length of a ship, nor the position of her features, can be estimated with any degree of accuracy unless a broadside view is obtained. Fig. 31 shows how the apparent positions of a ship's features are altered by the foreshortening of her profile when she is inclined away from or towards the observer.

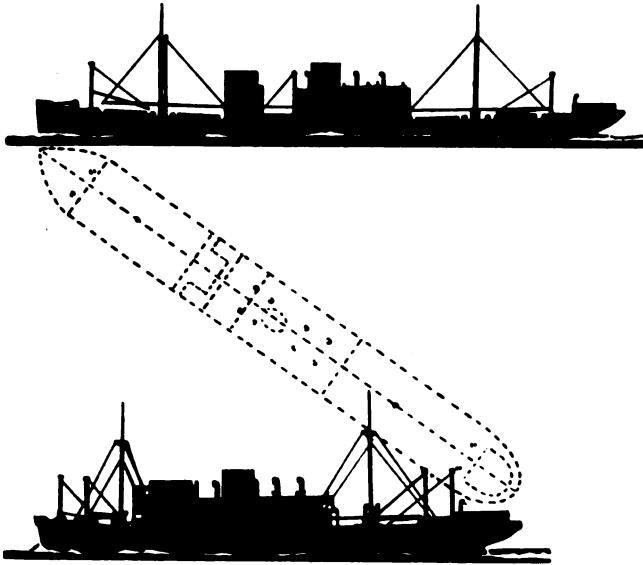


Fig. 31

The three simple methods which follow are recommended for judging the approximate length of a merchant ship.

Method A (Fig. 32). Two factors must be known : (1) range of observed ship (obtained by instruments), and (2) distance between observer's eye and outstretched hand.

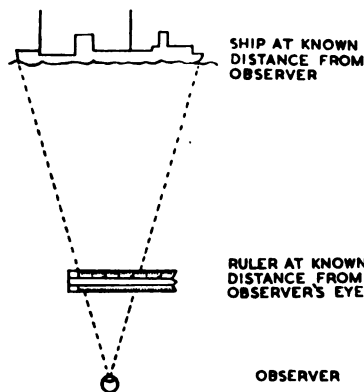


Fig. 32.—Length estimation—method A, with rule

A ruler, scaled in tenths of an inch, is held horizontally at arm's length in front of one eye, and the length of the ship is then measured in tenths of an inch ; care should be taken to hold the ruler at right angles to the line of sight. The actual length of the ship can then be determined from the table below.

TABLE FOR CALCULATING THE LENGTH OF A SHIP

RANGE	EQUIVALENT VALUE OF EACH 1/10TH OF AN INCH AS MEASURED ON THE RULER WHEN DISTANCE FROM EYE TO RULER IS :—			
	24 in.	25 in.	26 in.	27 in.
<i>yd.</i>	<i>ft.</i>	<i>ft.</i>	<i>ft.</i>	<i>ft.</i>
500	6.25	6	5.75	5.5
750	9.5	9	8.5	8.25
1,000	12.5	12	11.5	11
1,500	18.75	18	17.25	16.6
2,000	25	24	23	22
2,500	31.25	30	28.75	27.5
3,000	37.5	36	34.5	33
3,500	43.75	42	40.25	38.5
4,000	50	48	46	44
5,000	62.5	60	57.5	55

Example :—A freighter, when observed at a range of 2,000 yards by a man holding the ruler at a distance of 24 inches from his eye, appears to be 18 tenths of an inch long on the ruler. In the 24-inch column of the table 25 feet is given opposite a range of 2,000 yards; the length of the ship is therefore $25 \times 18 = 450$ feet.

Method B. This is based on simple proportion and it is not necessary to know the range. All merchant ships carry one or more lifeboats in a conspicuous position. In ships less than 500 feet in length these lifeboats are assumed to be 30 feet long, and in larger ships they are assumed to be 35 feet long.

The length of the ship is then calculated by judging the number of such lifeboats which could be fitted end to end in her length.

Example : If a large freighter's lifeboat fits 18 times into the length of the ship, her length will be $35 \times 18 = 630$ feet.

Method C. This method is also based on simple proportion. The height of the bridge, measured from the *upper deck*, replaces the lifeboat as the unit for calculating the ship's length. This height is taken as being 30 feet for ocean-going freighters and tankers, and 37 feet for the smaller liners and for cargo-liners.

Example : If the height of the bridge of a tanker fits 12 times into the length of the ship, her length will be $30 \times 12 = 360$ feet long.

ESTIMATION OF GROSS TONNAGE

A reasonably reliable estimate of the gross tonnage of a merchant ship (except a liner) can be obtained from her length. The graph reproduced in Fig. 33, which has been prepared from a statistical survey of a large number of ships, shows the approximate gross tonnage where the length of the ship is known.

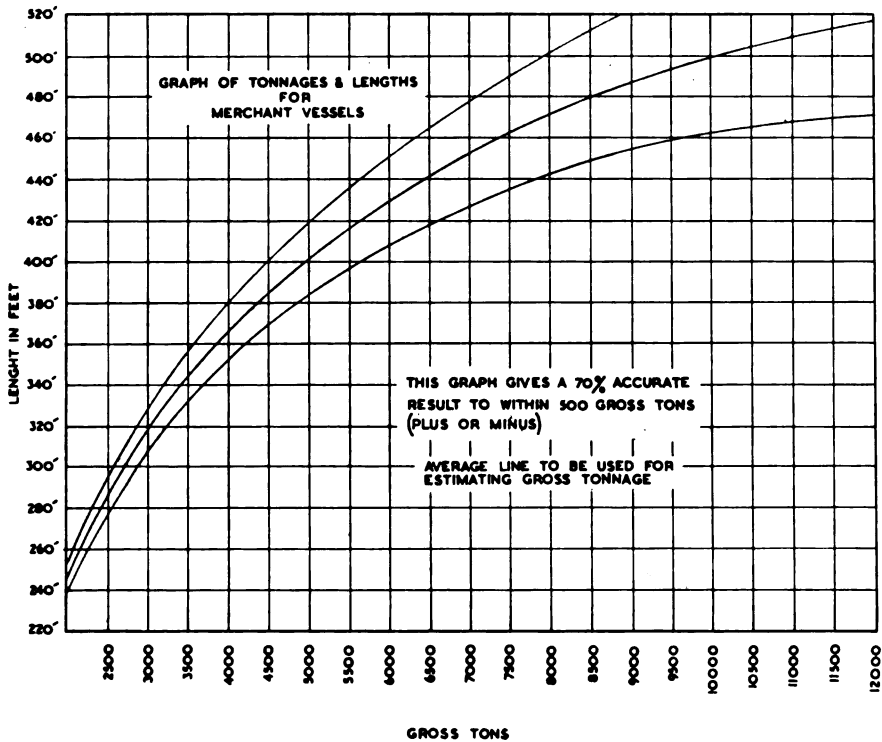


Fig. 33

The tonnage of liners cannot be estimated from this graph owing to a great variation in the proportion of their length to their tonnage. The sketches in Fig. 34 show a length to tonnage comparison of various types of liner from which a rough estimation can be made.

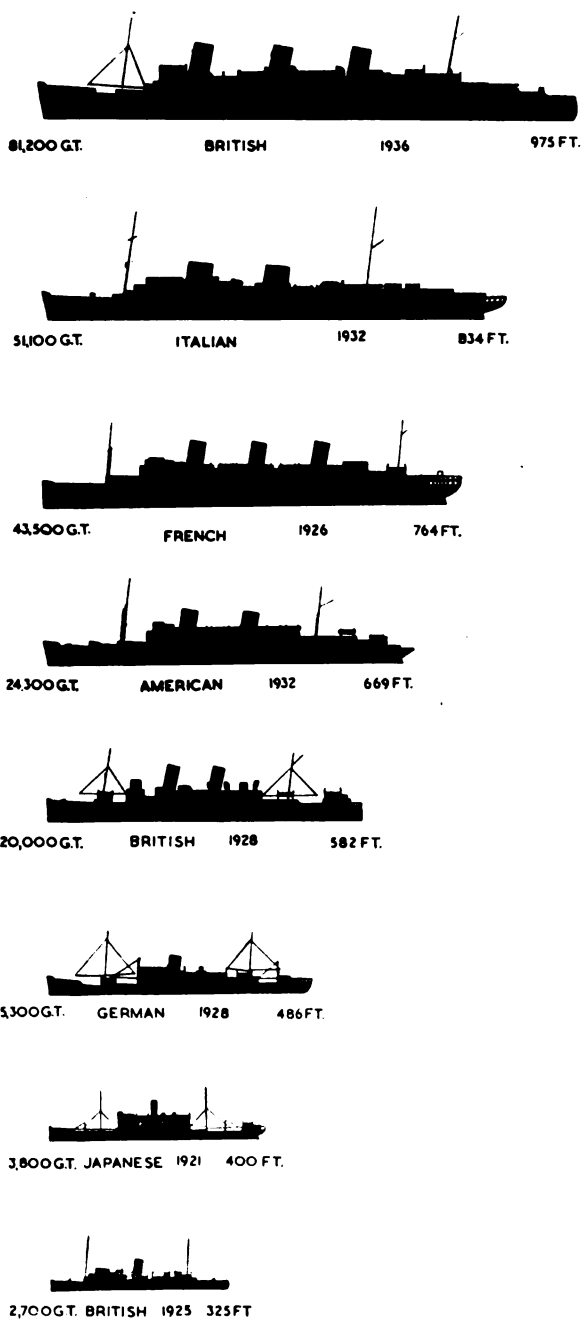


Fig. 34.—Length : Gross tonnage—comparison of passenger liners

Identification at Close Range

When opportunity affords a near view of a merchant ship many minor features can be distinguished, which, when taken in conjunction with those features already noted, may ensure positive identification of the ship.

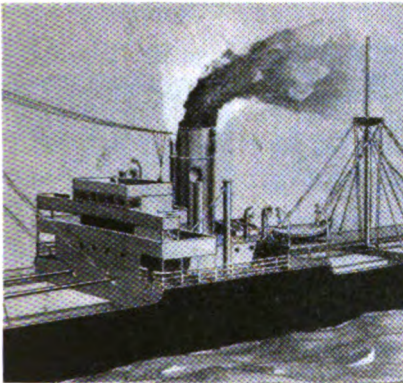
The following notes afford a guide as to which features should be observed :—

FUNNELS

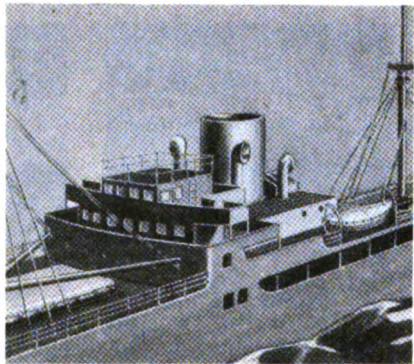
The shape, taken in conjunction with the profile and hull form, may give an indication of the age of a vessel.

The presence or absence of smoke may denote a coal or oil-fired steamer, or a motor ship. It should be borne in mind, however, that one or more of the funnels may be dummies for ventilation only.

Cowls or cinder screens on the tops of funnels should be noted.



(i) STEAM VESSEL



(ii) MOTOR VESSEL

Fig. 35.—Distinguishing features of funnels of steam vessels and motor vessels

A siren on the fore side of a funnel and an exhaust pipe on the after side denote a steam vessel ; their absence may denote a motor vessel.

DECKHOUSES

Their number and position may enable identification of individual ships of the same type or class.

DERRICKS

These may be light or heavy. Light derricks are usually stowed horizontally at sea, and are only rigged and topped up when approaching harbour ; they are omitted from recognition records because they are a common feature of all freighters. The absence of derricks should be noted, however, as this may help to differentiate between two vessels of similar outward appearance, such as a bulk freighter and a tanker (see Fig. 36).



(i) TANKER



(ii) BULK FREIGHTER

Fig. 36.—Types of engines-aft merchant ships

Heavy derricks are usually lashed to the masts at sea, and their presence should be noted as they may give an indication of the type of cargo carried.

OTHER FEATURES

Particular details such as the shape of ventilators and the type of boats' davits may assist in positive identification.

General Hints on Ship Recognition

BOW WAVES AND WAKES

The bow wave made by a merchant ship is not a good indication of her speed.* The size of the bow wave is determined more by the shape of the ship's bows than by her speed, and often a slow bluff-bowed freighter creates a bigger bow wave than a fast liner with fine lines. The extent of the wake (see Fig. 37) is a better indication of speed, especially when seen from the air, and when viewed from the air it will also indicate whether the ship has single or twin screws. A deeply laden ship leaves a longer wake than one in ballast, and a ship in ballast usually shows a pronounced propeller wash at the stern.

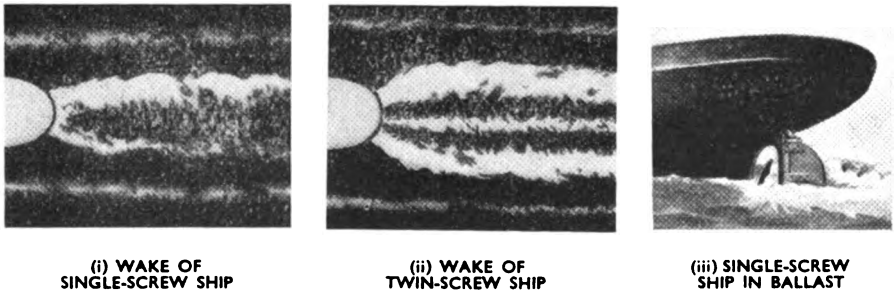


Fig. 37.—Differences between wakes of ships

PAINTWORK

In peace time, the colours of hulls, upperworks and funnels give a good indication of the ownership and identity of a merchant ship. The hull and upperwork colours, also funnel markings, of the principal steamship lines are given in *Lloyd's House Flags and Funnels* and in *Brown's Flags and Funnels*.

DECK CARGO

A deck cargo may alter considerably the appearance of a ship. If stowed on the well decks to the same level as the islands the ship may be mistaken at medium or long range for a flush-decker. Such cargo may hide deck houses and prevent the derricks from being lowered to their stowage position; the derricks would then be lashed to the masts and so might be mistaken for heavy derricks. Large cases painted the same colours as the upperworks might be mistaken for deck houses.

COMMON ILLUSIONS

Speed. Overestimation of speed is likely when—

- a large bow wave is seen ;
- the sea is choppy ;
- the ship is pitching ;
- she has a sharply raking bow ;
- she is crossing ahead of you ;
- she is at close range ;
- she is making smoke and steaming into a strong head wind.

* If the bow waves of a ship can be clearly seen and her length is known the following formula will give a fairly accurate estimate of her speed:— $S = 4/3 \sqrt{d}$, where s is the speed of the ship in knots and d is distance from her stem to the crest of her second bow wave.

Underestimation of speed is common when the ship is—
 approaching head on ;
 at a considerable range ;
 making smoke and running before a strong wind.

Size. A ship will look larger than she really is when—
 the sun is shining directly behind her ;
 in dull or foggy weather, or on a dark night ;
 the observer is near sea level ;
 she is similar in colour to the sky in the background.

A ship will look smaller when—
 the sun is shining directly behind the observer ;
 in very bright light or very clear atmosphere ;
 in a very calm sea ;
 she has a high superstructure, or many masts or king posts, or tall ventilators.

Mirage. On hot, clear days, the air near the sea often produces considerable refraction which may distort the shape of ships seen on the horizon and render identification impossible. Mirage may also produce images of ships in the sky, close above the horizon, which in reality are well below the horizon. These images are sometimes upside down.

DISTANCE OF HORIZON FROM OBSERVER

The distance to which an observer can see over the ocean on a clear day depends upon his height above sea level. The following table shows the distance of the horizon at different eye levels. If a ship is below the horizon but her funnels or superstructure are in sight and their height is known, her distance beyond the horizon can also be obtained from the same table.

HORIZON DISTANCE TABLE

HEIGHT OF EYE <i>ft.</i>	DISTANCE OF HORIZON <i>sea miles</i>	HEIGHT OF EYE <i>ft.</i>	DISTANCE OF HORIZON <i>sea miles</i>
5	2.57	40	7.26
10	3.63	45	7.70
15	4.45	50	8.12
20	5.13	55	8.52
25	5.74	60	8.89
30	6.29	65	9.26
35	6.79	70	9.61

One Sea Mile equals 6,080 feet, or roughly 2,000 yards.



Fig. 38

Example : An observer 60 feet above sea level sights the upper deck and superstructure of a liner below the horizon, and he knows that the upper deck of the liner is 40 feet above sea level :

distance of horizon from observer is 8.89 miles ;

distance of liner below horizon is 7.26 miles ;

distance between the two ships is 16.15 miles.

Means of Identification

By following the foregoing instructions a reasonably accurate picture of the merchant ship in question can be drawn to scale, and a good estimate can be made of her tonnage. If a medium or close view of her is afforded, reasonably reliable information can be deduced as to her speed, means of propulsion, and nature of cargo. From this data her route, her ports of departure, call and destination, and her nationality and line can usually be deduced fairly accurately.

Definite identification may be possible by reference to the following publications: *Lloyd's House Flags and Funnels*, *Brown's Flags and Funnels*, and *Lloyd's Register of Shipping*. Should these books of reference not be available, a signalled report, based on the foregoing methods of observation, can be sent in code and may enable the recipient to identify the merchant ship.

EXAMPLES :—

LONG RANGE

Sequence of features : king post ; mast ; king post ; superstructure with funnel ; mast ; king post ; hull form—"three-island" type.



Fig. 39

MEDIUM RANGE

Sequence of features : bow, raking ; stern, spoon ; funnel, average at $6\frac{1}{4}$; profile, composite ; masts at positions $3\frac{1}{4}$ and $8\frac{3}{4}$; king posts at positions 2, $4\frac{1}{2}$ and $10\frac{1}{4}$; length 450 feet ; approximate gross tonnage, 7,000 tons.

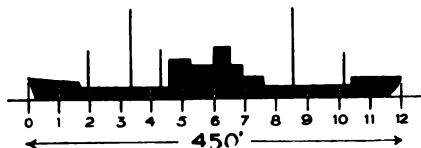


Fig. 40

CLOSE RANGE

Sequence of features : forecastle length 0 to $1\frac{1}{2}$, midcastle 5 to $7\frac{1}{4}$, poop $10\frac{1}{2}$ to 12 ; fore and after king posts are twin ; goalpost masts with heavy derricks ; six lifeboats ; superstructure on midcastle and poop ; deckhouse on poop ; deck cargo on fore and after well decks ; small mast on bridge.



Fig. 41

REMARKS

A freighter, well laden, and probably carrying general cargo ; and from the number of her lifeboats it may be deduced that she probably carries passengers as well. Presence of exhaust pipe and siren, and absence of funnel smoke, probably denote that she is oil burning. Speed about 12 knots, estimated from interval between first sighting and passing.

CHAPTER II

Ship Safety

THE term "ship safety" is used here to describe the normal precautions which are taken on board a warship to guard against fire, flooding, general damage, and casualties to personnel, whether caused by accident or by the enemy, and to minimise their effects. These precautions involve on the part of every person on board a thorough knowledge of the internal lay-out of the ship and of her fittings and equipment, and they also involve the strict observance by everyone of certain rules for safeguarding the ship and those who man her.

In addition to these precautions there is an organisation in each ship called "damage control" for maintaining her safety and for dealing at a moment's notice with any damage which she may suffer. This organisation is carried out by a number of highly trained teams who work under the direction of a control centre known as A.B.C.D. Headquarters, and whose sole object is to maintain the ship's fighting efficiency under all conditions.

In this chapter the precautions against flooding, general damage and casualties to personnel are described, and some general rules for the maintenance of ship safety are given. Also included are some general remarks on abandoning ship in the event of disaster.

Precautions in regard to fire, descriptions of fire-fighting equipment, and methods of tackling fires are given in Chapter III, and remarks on damage control and its organisation are given in Chapter XIV.

PRECAUTIONS AGAINST FLOODING

Water-tight Subdivision and Water-tight Openings

Every ship is divided by water-tight decks and bulkheads into a number of water-tight spaces, each of which may be further subdivided into water-tight compartments, as already explained in Volume I of this manual. Any flooding resulting from damage to the hull below the waterline can be confined by this water-tight subdivision to a small portion of the ship. Each compartment, however, has to be provided with an entry and an exit (through doors or hatches), means of ventilation (through ports, skylights, fans, trunks, cowl, doors or hatches), and means of illumination (either by ports, side-scuttles, sky-lights and deck-lights, or by electricity); in addition pipes, scuppers, shafts and rod gearing usually pass through it. These fittings and the places where they penetrate the decks or sides of the compartments must be made water-tight, and rules must be laid down for the opening and closing of all such openings, these rules being adapted to the use made of each compartment and to its liability to flooding.

Classification and Identification of Water-tight Openings

Datum Deck. The immediate liability of a compartment to flooding as a result of damage is dependent upon whether it is situated above or below the

waterline, and upon its distance from the ship's side. Water-tight compartments are classified according to their probable or possible risk of flooding, and this classification depends upon whether they lie below or above a horizontal division of the hull known as the "datum deck" (see Fig. 42).

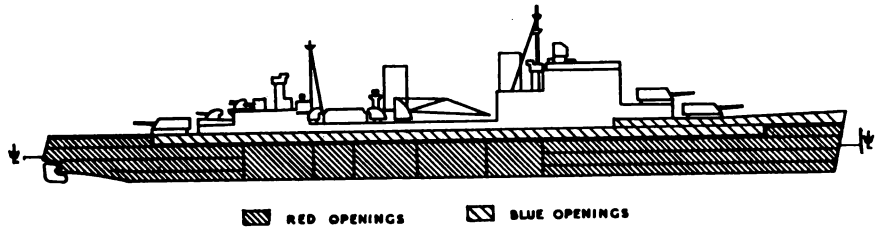


Fig. 42.—Section of typical cruiser showing datum deck, and division between red and blue openings

In small ships the datum deck is normally the upper deck ; in larger ships it is a deck not less than eight feet above the waterline. In large ships the datum deck is not the same throughout the ship because the flooding risks at the ends and sides are greater than in the centre, and therefore at the bows and stern the datum deck is one deck higher.

Red and Blue Markings. All compartments below the datum deck are deemed to have a *probable* risk of flooding, and their associated water-tight fittings are marked in RED.

Compartments above the datum deck are deemed to have a *possible* risk of flooding, and their associated fittings are marked in BLUE.

The degree of risk involved in leaving open a door, hatch, or other water-tight fitting is thus indicated by the colour RED or BLUE.

Compartments in the superstructure need only to be weather-tight, not water-tight, and their fittings are therefore not marked in a distinguishing colour.

Control Markings. The priority in importance of the various openings having been thus decided, it is necessary to classify them further in accordance with the use to which they are put. The basic principles of this classification must be to ensure :—

- (i) the safety of the ship ;
- (ii) the maintenance of habitability and the free flow of the ship's traffic ;
- (iii) the provision of access for inspection, routine and other purposes.

All doors, hatches and water-tight fittings which bear the red or blue marking are therefore also marked with one of the letters X, Y, Z, or O, or the word ROUTINE. These are called "control markings," and each of the five categories together with its signification is shown in the table on page 31.

Qualifying Symbols. For some openings it is necessary to qualify the control markings by "qualifying symbols." These are shown, with their significations, in the table on page 30.

Identification Markings (Fig. 43). These consist of figures and letters painted on bulkheads and water-tight fittings for the purpose of :—

- (i) indicating the position of a compartment within the hull or superstructure ;
- (ii) differentiating similar fittings from each other ;

- (iii) indicating the number, type and position of any fittings in a compartment or in adjacent compartments ;
- (iv) indicating the nature or type of any adjacent compartments.

The system of marking is described in Chapter XIV, the main principles being that :—

- (i) decks are numbered consecutively downwards from No. 1 deck, which in ships such as cruisers is the forecastle deck, in flush-decked ships is the upper deck, and in aircraft carriers is the flight deck ; decks above No. 1 deck are numbered 01, 02, 03, etc. consecutively upwards from No. 1 deck ;
- (ii) sections of the ship lying between main transverse bulkheads are lettered consecutively from forward aft (omitting the letters I and O), 'A' section being that which lies between the stem and the first main transverse bulkhead.

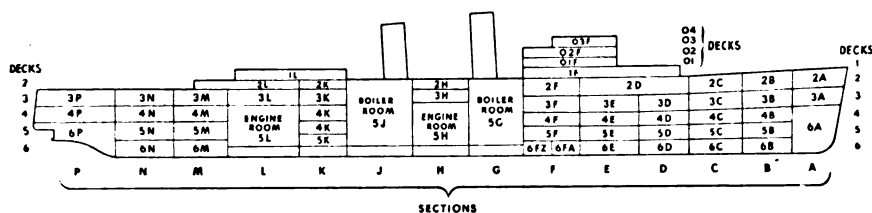


Fig. 43.—Longitudinal section of a cruiser showing method of identification markings of main compartments

Thus, if a compartment was marked " 3C," it would lie between the second and third decks and between the second and third main transverse bulkheads; and all water-tight fittings in that compartment would be marked " 3C " followed by letters and figures denoting their positions within the compartment.

A main transverse bulkhead is also marked with a number denoting the frames between which it lies, the frames of a ship being numbered consecutively from the stem to the stern. Thus a bulkhead marked 90 would lie across the ship at the ninetieth frame of her hull.

Basic Rules for Opening and Closing Water-tight Openings

The basic rules governing the opening and closing of each category of water-tight opening are given in the table on page 31. These rules should be thoroughly understood and strictly observed by everyone, *because the most certain insurance against the consequences of flooding is the strict compliance by everybody at all times with the regulations for opening and closing water-tight openings. Good water-tight discipline is the surest means of controlling the results of flooding.*

Closing Water-tight Openings in Emergency

In an emergency the order " *D'ye hear there ! Close red and blue openings* " will be passed. At this order all doors, hatches and water-tight fittings so coloured must be closed immediately, *first those coloured red, and then those coloured blue.*

QUALIFYING SYMBOLS

SYMBOL	APPLICABLE OPENING	SIGNIFICATION
2 CLIPS	Y or Z door or hatch	Used where it is not practicable to keep a door or hatch fully clipped (e.g. a main traffic door through a transverse bulkhead). Two clips only are to be closed, <i>except when the ship is in the "Battle State" or in times of emergency, when all clips are to be closed.</i> The two clips to be closed are those on the side opposite to the hinges, and they should be indicated by a double black line painted on the door or hatch.
ACTION	X, Y or Z openings	Indicates that for action purposes the opening may be opened for special periods in accordance with the ship's orders.
FIRST GUN	Z doors	When the "Battle State" is assumed these doors are kept open until those using them are at their action stations, when they should be closed and secured.
VENT— 2 CLIPS	X, Y or Z hatches	When magazines are in the venting condition the hatch is closed and secured with two clips only. The two clips to be closed are those <i>nearest</i> the hinges but <i>not on the hinged side</i> . They are indicated by a double black line painted opposite them on the hatch. At other times the hatch is fully clipped in accordance with its X or Y marking.
VENT— NO CLIPS	X, Y or Z hatches	When magazines are in the venting condition the hatch is closed but not clipped. At other times the hatch is fully clipped in accordance with its X or Y marking.
 (YELLOW)	'O' or Routine Openings	Additional openings to be closed at at "Gas alarm." They are not to be opened without permission until after the order "Gas clear."
 (LETTERING IN RED)	X or Y doors or hatches	Indicates that the door or hatch may be left open, except in emergency or in the first state of readiness.

BASIC RULES FOR OPENING AND CLOSING RED AND BLUE WATER-TIGHT OPENINGS

CONTROL MARKING ON DOOR, HATCH, VALVE, OR OTHER WATER-TIGHT OPENING	SIGNIFICATION
X	Permission to open when at sea must be obtained from A.B.C.D. Headquarters (H.Q.I.), and when in harbour from H.Q.I. or the Officer-of-the-Watch (O.O.W.), and it should be closed again and secured immediately after passing through. If permission has been obtained for it to remain open, provision must be made for it to be closed again immediately in an emergency ; and when reclosed the fact must be reported to H.Q.I. or the O.O.W.
Y	May be opened for passage without permission, but must be closed and secured again immediately after passage. If desired to keep open, even for a short time, permission must first be obtained from the H.Q.I. or the O.O.W., and its subsequent reclosing must be reported to H.Q.I. or the O.O.W.
Z	Left open except when in Battle State or in an Emergency. It may be closed by special order, and when so closed it must be treated as a " Y " opening.
O	Always left open, but may be closed by special order and when so closed it must be treated as a " Y " opening.
ROUTINE	This marking is used to indicate an opening which, though classified as an " X " or a " Y " opening, has to be opened for inspection purposes at certain routine times. Instructions for its opening and closing are also posted alongside the opening.

Ventilating Systems

A ship is ventilated by both " natural ventilating " and " forced ventilating " systems.

Natural ventilation is effected by means of doors, scuttles, hatches and skylights, and is confined to those compartments above the waterline which are directly below the weather decks and next to the sides of the ship.

Forced ventilation comprises a system of fans and air-tight trunking whereby fresh air is drawn by a fan through a " mushroom head," or cowl, situated on one of the weather decks, and then forced along the trunking to compartments not provided with natural ventilation, which usually lie on or below the datum deck ; after circulating round the compartment the used or foul air is exhausted to the weather decks, also through trunking.

The trunking of forced ventilating systems constitutes a serious risk to the water-tight integrity of a ship because water in a flooded compartment may flow through the trunking and flood other compartments which otherwise would be safe from flooding.

Each forced ventilating unit is therefore confined to ventilating the space between two main athwartship bulkheads, and such bulkheads are never pierced by ventilation trunking. Where the trunking passes through a deck or any water-tight bulkhead it is provided with a water-tight sluice valve, which is marked in red or blue and also with the appropriate water-tight marking and symbol; some of these valves can be remotely operated by means of rod gearing.

Each unit is also provided with gas-tight valves fitted in the trunking just below the inlet and exhaust mushroom heads, so that noxious gases or flood water on deck can be prevented from getting below.

Living and working spaces in fairly constant use, some store rooms such as flour stores, and the magazines, are ventilated as continuously as possible. Other compartments may be provided with ventilating systems which are normally closed down, and are opened up only when the compartments are in use, or in conformity with a special routine; instructions regarding the ventilation of such a compartment are usually displayed in the vicinity of the compartment or of its ventilating fan.

Many compartments, the double bottoms and the water-tight compartments before the collision bulkhead, for example, are not provided with means of ventilation. As these may therefore contain poisonous, inflammable, or explosive gases, or the air in them may lack sufficient oxygen to support life, certain precautions which are described later in this chapter, under the heading "Precautions Against Casualties," must be taken before anyone is allowed to enter or work in them.

Pumping and Draining Systems

Most ships are provided with one or more pumping systems by which flooded compartments low down in the ship can be pumped out when the flow of water into them has been checked. Flooded compartments higher up in the ship can be similarly pumped out by portable pumps.

Some compartments situated above the level of the main suction systems may be provided with drain pipes to enable flood water to be drained to the bilges, or to a lower compartment, whence it can be pumped overboard by the main pumping system. Some compartments above the waterline, such as bathrooms and galleys, are provided with scupper pipes to drain off sullage and waste water; these pipes, and those of the weather deck scuppers, usually lead close within the ship's side to a position just above the waterline.

Suction pipes, drain pipes and scupper pipes may constitute a serious flooding risk if they are damaged or if the compartment in which they are situated is flooded. They are therefore fitted with water-tight valves where they pass through decks, bulkheads, or the ship's side, and each valve is coloured red or blue and marked with its appropriate water-tight marking and symbol.

One of the chief points to remember in regard to pumping and draining systems is that they can easily be choked and put out of action by rubbish, bits of clothing and any other article which is not securely stowed. Great care should always be taken to ensure that kit, stores and any moveable equipment are correctly and securely stowed to ensure that they will not be displaced by the movement of the ship in heavy weather, or, as far as possible, by the shock of an explosion.

PRECAUTIONS AGAINST GENERAL DAMAGE

Duplication and Dispersal of Machinery

Important auxiliary machinery such as pumps and dynamos are duplicated and dispersed so that one hit will not put out of action the services they provide. In addition, there are alternative installations, either fixed or portable, which can readily be brought into action if the main installations are damaged ; these include the secondary steering gear, leads for electric power and light, and portable pumps and hoses for pumping out compartments or providing water for fire-fighting.

Provision of Damage Control Equipment

Equipment for fire-fighting, repairing the ship's structure and stopping leaks, is provided in special stowages at various focal positions throughout the ship. To ensure the immediate availability of such equipment it is essential that it should be maintained in a serviceable condition, kept in its correct stowage, and not tampered with or used for purposes other than damage control.

Included in this equipment are battery-operated hand lamps placed in key positions and connected with the ship's main lighting system ; if the main lighting system fails the lamps are automatically lighted. The burning time of these lamps is limited because they are battery-operated, and they should therefore never be switched on except in emergency.

Duplication and Dispersal of Stores

The most important stores are distributed between two or more widely separated store rooms to ensure, as far as possible, that a proportion of such stores will be available if the ship is damaged. In addition, when the ship is liable to go into action, emergency dumps of rations are provided in different sections of the ship.

PRECAUTIONS AGAINST CASUALTIES

First Aid

Everyone should possess a thorough knowledge of first aid and be trained in its practice. This is a duty and a service to one's shipmates.

Precautions in Action

Observations on some of the main causes of casualties in action, and the precautions which should be taken to guard against them, are given below.

- (i) *Flash from explosion* spreads much further than do splinters, and it can travel through pipes or trunking to a considerable distance from the actual scene of the explosion. Flash is, however, of very short duration, and even thin clothing will afford some protection. In action, or when action is imminent, it is therefore most important that everyone should be completely covered with clothing and that anti-flash gear should be worn.
- (ii) *Shock from violent explosion*, from mine or torpedo hits for example, may be so severe that men are thrown upwards with such force that their heads or necks are broken on the deck above, or their ankles are broken when they come down again. In action every man not actually employed should therefore lie down on his back with his hands behind his head.

- (iii) *Splinters* travel horizontally rather than vertically, so lying down athwartships with the feet outboard affords the best protection.
- (iv) *Poisonous Fumes.* Gas masks provide a certain degree of protection from poisonous fumes, so they should always be at hand in action. It should be remembered, however, that a gas mask only acts as a filter and does not provide oxygen, and that when attacking a fire (which consumes oxygen) one of the special breathing apparatuses supplied should therefore be worn if the fire is between decks or otherwise enclosed.

Precautions when Opening Unventilated Compartments

The danger in the atmosphere of an unventilated compartment has already been mentioned in this chapter. The presence of inflammable, explosive, or noxious gases, or the lack of oxygen, may be due to the liquid formerly in the compartment, to the stores stowed in it, or to the paint with which it has been coated. Unventilated compartments usually have a notice painted on the door, hatch, or manhole cover, which reads "*WARNING—Unventilated Compartment. Test Air Before Entering.*"

THE SAFETY LAMP

Safety lamps are provided in all ships for testing the air of a compartment to ensure that it is safe for a man to enter and work in it. A safety lamp will not indicate before entry whether the compartment needs ventilating.

The lamp is oil-burning, and its flame is protected from contact with explosive or inflammable gases by a gauze cylinder which can be locked in position to ensure against the flame accidentally contacting the gases. Before using the lamp the protecting gauze should be inspected to see that it fits correctly and is undamaged, and the wick must be correctly trimmed so that the lamp burns with a clear and steady flame in a normal draught-free atmosphere. When the lamp has been lit and correctly adjusted it should be locked, and the key should be kept by the man who issues the lamp, and not by the user, to ensure that if the lamp is extinguished in a dangerous atmosphere the user cannot relight it. When carrying the lamp to the compartment its flame should be protected from draughts.

Testing with the Safety Lamp. When testing a space for dangerous gases or lack of oxygen the flame of the lamp should be kept in sight and watched for changes in its appearance. If it burns dimly or unsteadily, or increases in size and is drawn upwards to a fine point, or if it is extinguished, or a "cap" forms over the top of the flame, then the space is dangerous and must be thoroughly ventilated.

Before entering the compartment the lamp should be held first at the entrance; then at arm's length from the entrance; then as high as possible, on a stave if necessary; and finally as low as possible, on the end of a line if necessary.

If the flame burns steadily in all these positions the compartment may be entered, and the lamp should then be tried in the upper and lower corners of the compartment, and in each of its bays (if any). During these tests communication should be maintained with someone outside the compartment, and should the lamp indicate the presence of a dangerous gas the compartment should be evacuated, thoroughly ventilated, and then tested again before using it.

Should it be necessary to enter an unventilated compartment before first testing the air in it, to rescue someone inside for example, a breathing apparatus which provides its own oxygen or air, such as the Salvus or Pattern 230 breathing apparatus (see page 55) should always be worn. The Service gas mask is useless for this purpose because the noxious gases in an unventilated compartment usually lack oxygen, and the gas mask does not provide oxygen but merely acts as a filter.

RULES FOR SHIP SAFETY

The following general rules, and rules for the care and maintenance of fittings and equipment, should be observed by everyone.

General Rules

- (i) Report flooding, fire, or any other dangerous incident immediately, to A.B.C.D. Headquarters when at sea, and to the Officer of the Watch when in harbour.
- (ii) Tackle flooding immediately and stop it spreading by closing all water-tight openings in the vicinity.
- (iii) Observe the rules for opening and closing water-tight openings. Ensure that closed doors and hatches are securely fastened.
- (iv) Tackle a fire immediately and close all ventilation in its vicinity. Study the methods of fire-fighting and learn thoroughly the correct use of all fire-fighting appliances. Ensure that especially inflammable articles, such as paint pots, are returned to their correct stowage immediately after use.
- (v) Know your ship thoroughly, from stem to stern and from truck to keel; you should be able to find your way to any part of her in the dark.
- (vi) Keep your personal kit correctly and securely stowed, your hammock tautly lashed and correctly stowed, and your locker door securely shut. See that no loose gear is left sculling about the mess-decks. Don't hang gear on valves, rod-gearing or clips, and don't sling hammocks in the wake of doors or operating gear.
- (vii) See that all stores and equipment are kept correctly and securely stowed. Before leaving a store room or compartment see that any radiators or other heating appliances, and the lights, are switched off. See that the ventilation and water-tight openings are closed, and that any which should by regulations be left open are left correctly adjusted. Ensure that no litter or unstowed gear is left in the compartment.
- (viii) Never allow any damage control equipment—particularly secondary lighting lamps, torches, and special tools—to be used for any other purpose than damage control. Keep damage control equipment in good order, and learn the maintenance rules and routine.
- (ix) Ensure that all life-lines, and ladders at hatchways, are correctly rigged.
- (x) When at sea under war conditions do not allow any unauthorised lights or smoking above decks between the times of "darkening" and "undarkening" ship. A lighted match can be seen in the dark from a distance of 3 miles, and a burning cigarette from one mile.

- (xi) When at sea under war conditions do not throw anything overboard except at the times ordered ; a trail of " gash " in the wake of a ship will give away her position and course.
- (xii) You must be able to swim, otherwise you will be a burden to your shipmates if you have to abandon ship. At sea in war always carry your life-jacket with you and test it daily. Have your anti-flash gear and gas mask always handy for action stations. At sea in war sleep with your clothes near you so that you can be ready at a moment's notice for any emergency.
- (xiii) Always carry a knife in peace or war, and learn how to make the simple knots.

Rules for Maintenance of Fittings and Equipment

- (i) Report any defects at once, in accordance with the ship's orders.
- (ii) Keep the bearing surfaces of water-tight fittings and their rubber sealing strips clean and free from paint. Keep door clips, hatch nuts and hinges, and the moving parts of valve rod-operating gear, clean, greased and free from paint.
- (iii) Lower hatch covers, and close doors, gently ; careless handling may distort them and render them ineffective. Don't hammer door clips or hatch nuts into place ; securing them hand-taut is sufficient.
- (iv) Don't remove door clips for cleaning ; their re-assembly and refitting is a skilled job.
- (v) Keep the lettering of tallies readable ; never paint them over. When necessary to paint over directions, symbols and markings, ensure that they are re-painted with the least possible delay. All markings should be " centre-popped," or " cut in," to facilitate repainting them correctly.
- (vi) Fire hoses should always be stowed ready for running out. Ensure that the rubbers in the hose hydrant connections are in place, and inspect the hoses carefully for cracks or tears. Handle hoses with care, especially over decks with sharp projections. Handle carefully hose connections, nozzles and branch pipes, and ensure that they function correctly.
- (vii) Never put a fire extinguisher back in its stowage if it is empty, and make sure that all those in place are loaded and ready for functioning. Never paint over fire extinguishers.

EMERGENCY STATIONS AND ABANDONING SHIP

Abandon Ship

If, after being seriously damaged, all measures taken to save the ship are unsuccessful, preparations will be made to abandon her in an orderly manner and with the least possible loss of life.

To abandon ship in a heavy sea or when on fire, for example, will be a severe test of good discipline which will call for coolness, steadiness and sometimes self-sacrifice. Strict obedience to orders is essential and strict silence must be maintained. Any signs of panic or loss of self control must be suppressed. Before abandoning ship, hands are piped to " Emergency Stations."

Emergency Stations

The object of the order "Hands to Emergency Stations" is to clear the ship between decks of all hands not employed on damage control duties. This will ensure the maintenance of water-tight integrity, and at the same time give the damage control parties room to carry out their work.

At this order, all hands not employed with the damage control parties should fall in on the upper deck at their appointed emergency stations and keep silence. They will then be available if required for assisting the damage control parties or clearing away boats and rafts and preparing to abandon ship.

No-one should leave his post until ordered to do so. Before abandoning a compartment all water-tight openings in it should be closed, all machinery stopped, and electric current switched off. After leaving, the hatch or doorway of the compartment should be closed and clipped. After abandoning a compartment report the fact to A.B.C.D. Headquarters and then go to the upper deck and report to the nearest officer for orders.

Boats and rafts are launched or lowered by order, and then men are detailed to man each boat or raft, by means of falls, life-lines, jumping ladders or scramble nets. Special provision is made for evacuating the sick and wounded together with the medical staff. Each boat and raft is tended while lying alongside the ship by means of boat-ropes and lines until, having received its full complement, it pulls clear of the ship. The final order to abandon ship is then given to any who may still be on board.

Abandoning Ship

When leaving a sinking ship you should immediately swim well clear to avoid air bubbles and wreckage which may rise to the surface with considerable force. If the ship is drifting it is better to leave her over the weather side, otherwise it may be difficult to swim clear of her. On the other hand oil fuel may extend for a considerable distance from the weather side of a drifting ship, and whenever possible oil fuel should be avoided, by swimming below it if necessary to clear water. If you are unable to reach a boat or raft get hold of any floating wreckage.

If the ship has a list when you leave her, bear in mind that :—

- (i) if you leave by the low side you may be struck by the masts, funnels, or superstructure if the ship capsizes before you can swim clear ;
- (ii) jumping from the high side involves a risk of hitting the bilge keel, or other projections such as the propellers, and if the under water part of the hull is exposed barnacles may injure your feet and hands ;
- (iii) it is therefore preferable to leave by the forward or after end of the ship if possible.

When rafts or boats have pulled clear of the ship they should secure to each other in groups by their painters or tow-ropes ; this facilitates the adjustment of crews and transfer of wounded and stores, and enables orders to be passed easily. One or two boats should be detailed to cruise around the area to pick up any other survivors. Advice on how to make the best of the arduous living conditions in boats and rafts is given in Volume III of this manual.

CHAPTER III

Fire-fighting

IT is essential to the safety of his ship that every seaman should have a working knowledge of the causes of accidental fires, and of how to prevent, control and extinguish them.

Fire is dependent upon three elements, namely :—

- (i) *flammable material*, such as paper, oil, petrol and wood ;
- (ii) *heat* ; and
- (iii) *oxygen* which, together with heat, ignites the fuel.

These three elements may be represented by the three sides of a triangle (see Fig. 44) ; the triangle is only complete, and fire will only occur or continue, while all three are present.

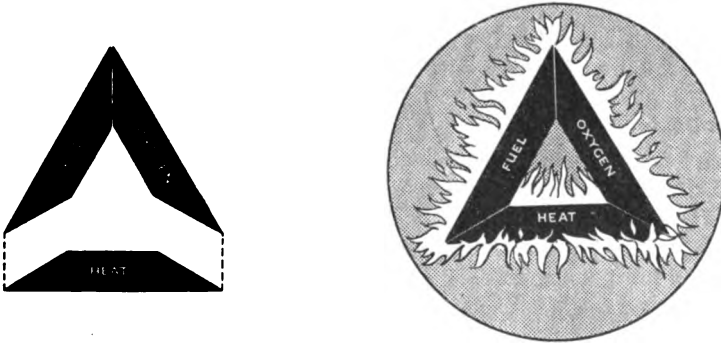


Fig. 44.—Fire triangle

Fire prevention consists of keeping these three elements separated by paying careful attention to the stowage of inflammable substances and liquids and to their protection from sparks, and by observing the necessary precautions in the disposal of burning material such as smouldering cigarette ends and matches.

Fire-fighting consists of the elimination of one or more of these three elements. This is done by removing the inflammable material or preventing more of it from becoming ignited, or by cooling the inflammable material and the air in its vicinity to a temperature below ignition point, or by smothering or blanketing the flames to prevent sufficient oxygen from reaching the seat of the fire, or by shutting off or sealing all ventilation in the vicinity.

FIRE PREVENTION

With the exception of those caused by enemy action, most fires on board ship can be prevented by keeping things in their proper place, maintaining cleanliness and tidiness, and obeying the relevant regulations. The following notes on fire prevention are dealt with under the three headings of inflammable materials, heat and oxygen.

Inflammable Matter

Everything of an inflammable nature has been eliminated from H.M. ships as much as possible, but ships which have to steam, fight, and yet be habitable must carry and incorporate liquids and materials which will burn or explode. The precautions which must be taken for the stowage and handling of such matter are given here.

PETROL

This constitutes one of the greatest fire dangers on board ships and every effort has been made to reduce the amount carried. Its use, however, is essential in aircraft carriers and in small petrol driven craft such as M.T.Bs.

Petrol should always be kept in the authorised stowages. No unauthorised stocks such as "cigarette lighter fuel" should be allowed on board.

Stringent precautions are laid down and must be observed when petrol is being embarked or transferred; the most important are :—

- (i) no smoking or burning of naked lights is allowed in the vicinity;
- (ii) fires such as galley and incinerator fires must be extinguished;
- (iii) wireless transmission is not permitted because of the danger of sparking;
- (iv) ports in the ship's side adjacent to petrol tanks must be kept closed;
- (v) sentries must be posted;
- (vi) ships must fly the approved danger signals.

FURNACE FUEL AND DIESEL OIL

While every precaution is taken in designing the ship to confine these inflammable liquids to positions of safety, there is always the possibility of leakage, especially when the ship is damaged. Every man must look out for such leaks and report them immediately. Any escaped oil must be cleaned up at once, and the cause of the leak dealt with; cotton waste or rag used for this purpose is particularly inflammable and must not be left lying about.

WOOD.

All woodwork has been replaced in ships by metal wherever possible, but some is still necessary.

Timber should not be stowed near hot surfaces, or where it can become saturated with inflammable liquids.

PAINT

Paint pots and brushes, as well as paint, should be stowed in the paint store; keeping pots of paint in other parts of the ship for "touching up" constitutes a highly dangerous fire risk. Coats of paint, especially of oil paints, should be kept to a minimum.

CINEMA FILM

Celluloid film of 35 mm. size is highly inflammable, especially as it contains its own oxygen; it must be handled with great care and stowed in metal containers when not actually in use. *The gases given off by burning cinema film are highly poisonous, and if confined can become explosive.*

CLOTHING, HAMMOCKS AND OTHER KIT

These must be stowed in their correct places. Kit lockers must be clipped shut to prevent their contents from falling out and thus being exposed to the danger of a fire in the event of action damage.

COOKING FAT

This must be stowed in a cool place, and when being used in the galley must not be left unattended owing to the danger of its catching fire.

PAPER

All paper must be stowed where it cannot be spread about the ship by an explosion. Scrap paper must be kept collected and disposed of. Books and papers must be stowed away, and not tucked overhead near sleeping billets.

COTTON WASTE AND RAGS

When supplied for cleaning purposes, cotton waste and rags must not be left lying about ; they must be placed in metal bins and disposed of regularly. Such materials are particularly dangerous when soaked with oil or petrol and may well be a source of spontaneous combustion.

EXPLOSIVES AND FIREWORKS

All explosives, including fireworks, obviously constitute a grave risk and regulations for their safety are the result of other people's unpleasant and unfortunate experience. These regulations are laid down in the *Naval Magazine Regulations*, and are also published in the ship's orders and prominently displayed as posters in danger areas. Every man on board must observe these and other regulations concerning explosives.

Heat

Where heat is expected, in galleys and boiler rooms for example, extra care must be taken to keep everything clean and to avoid collections of grease or rubbish. A typical example is afforded by galley hoods, where grease is likely to collect in the exhaust trunks and may easily be set alight by sparks from the galley range or by flames from a "boil-over" of cooking fat.

Steam pipes are lagged to confine the heat in the pipes and to protect adjacent surfaces from the heat in the pipes. Any damage to the lagging of steam pipes should be reported at once, and combustible materials should not be stowed near them.

Spontaneous Combustion

This is a dangerous source of heat which causes fire. Chemical action such as that which occurs between oil and the fibres of cotton waste can easily generate sufficient heat to cause a fire.

Smoking

The cause of numerous fires has been smoking ; and failure to observe the smoking regulations, or to see that cigarettes, pipes, or matches are properly extinguished, may result in a fire just as damaging as one caused by enemy shells. Cigarette ends should never be thrown out of scuttles or over the side ; they may fall into boats or lighters lying alongside, or be blown back by the wind and set fire to something on deck.

Sparks

Fires can be started by sparks from incinerators and galley funnels, so it is important to keep the funnels swept clean.

Sparkling of electrical apparatus and shorting of electric leads also cause dangerous generation of heat, and great care must be exercised in the main-

tenance and use of such equipment, particular attention being paid to wandering leads and temporary connections.

Oxygen

Where air is present there must be oxygen, and it is impossible to eliminate it. Keeping water-tight doors and hatches closed when not in use, however, prevents the spreading of fire as well as flooding, but in fire it is as important to close the doors and openings above the waterline as it is to close those below it. The control of ventilation in the vicinity of a fire is most important.

PRINCIPLES OF FIRE-FIGHTING

Once a fire has started it will probably spread very rapidly, and one of the first principles of fire-fighting is to tackle a fire immediately it is discovered with whatever means are at hand. Many a potentially dangerous fire has been extinguished at its start by the resolute initiative of one man alone ; it must be remembered, however, that a fire may quickly get beyond the control of the man or men in the vicinity. At the same time as a fire is tackled, warning of its outbreak should, therefore, be given by shouting " FIRE " and by informing the Officer of the Watch and any other responsible person by telephone or messenger. This will not only ensure speedy assistance, but will also ensure that the necessary precautions are taken to prevent the fire from spreading.

The fire-fighter's objective is to remove from the fire one or more of the elements upon which combustion depends ; he must therefore strive to *starve* inflammable material, *cool* the material and its surroundings to below their ignition temperature, or *smother* the fire by preventing air, and therefore oxygen, from reaching it.

Starving

This starving of the fire is effected by removing inflammable materials from the vicinity of the fire and cutting off all liquid fuel supplies in the area.

Fires fed by inflammable liquids can be starved by projecting a layer of foam over the surface of the burning liquid. This layer of foam blankets or smothers the burning surface, thus preventing the inflammable vapour from reaching the oxygen in the air.

Cooling

Cooling is effected by water, which should if possible be applied to the burning material and not the flames. When the flames have died out it is essential thoroughly to cool everything that was burning, and its surroundings, to prevent it from re-igniting. It must be borne in mind, however, that although an unlimited supply of sea water is usually available to a ship for fire-fighting, its excessive use may endanger the ship for the reasons given below.

- (i) Water is heavy, and, if used in sufficient quantities, may list the ship and even capsize her.
- (ii) All water used at the fire will eventually have to be pumped out of the ship.
- (iii) Liquid fuels are lighter than water and will float on its surface, and under certain conditions the excessive use of water may therefore cause burning fuel to overflow from the tanks and so spread the fire.

- (iv) Sea water is particularly harmful to electrical equipment and its use on such equipment should therefore be avoided if possible.
- (v) It is dangerous to direct a jet of sea water at live electrical apparatus, owing to the danger of an electric shock ; the danger of a shock with fresh water is not nearly so great.
- (vi) Though water will prevent explosives from catching fire it will not necessarily stop them burning once they are alight because explosives contain their own oxygen.
- (vii) Water applied to some substances produces inflammable gases ; an example is the production of acetylene gas when water makes contact with the calcium carbide contained in some smoke floats and sea markers.
- (viii) If water makes contact with certain light-weight metals when they are burning it decomposes them and accelerates their burning ; this applies to magnesium alloys, which are as widely used in the construction of aircraft as are aluminium alloys.

All ship fire-fighting appliances are therefore designed not only to use water effectively, but to use it sparingly.

To cool everything adjacent to a burning compartment is very important. A compartment of a ship is like a metal box (see Fig. 45) ; it has four sides, a top, and a bottom, all of which will become heated if fire breaks out in it, and this heating may spread the fire. The decks and bulkheads of adjacent compartments must therefore be cooled by spraying them with water, but it must be used sparingly.

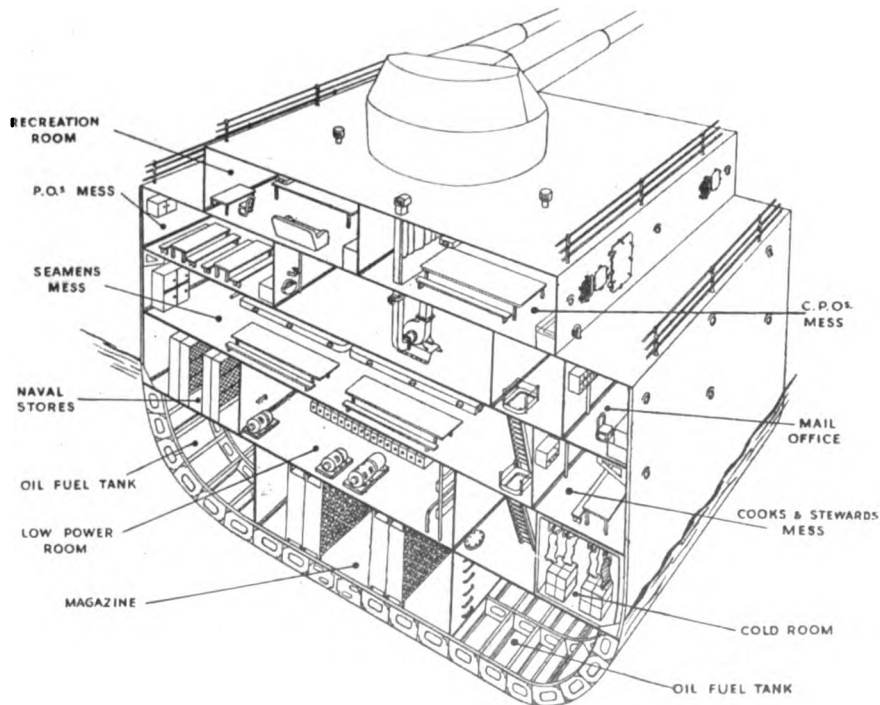


Fig. 45.—Typical layout of compartments of a ship

Smothering

The object of smothering a fire is to prevent oxygen reaching it ; smothering alone may extinguish it, but other methods will often have to be used as well. Smothering includes the use of steam, carbon dioxide, or methyl bromide, all of which repel oxygen and so have a smothering effect.

Wherever practicable, ventilation in the vicinity of a fire should be shut down, but if there is a large amount of smoke it may be necessary to leave an outlet open so that it can escape.

It is possible to extinguish a fire of burning inflammable liquids by sealing the compartment in which it is situated. It may not be possible to effect a complete seal, but as long as there are no openings low down through which air can reach the seat of the fire this method has been found successful ; it is essential, however, to keep adjacent compartments and structures cool with water-spray.

Re-ignition

Once a fire has been extinguished there is always a danger of it lighting up again, particularly if it was extinguished by smothering.

Smoke

Unless the fire is attacked in its very early stages the compartment will be filled with smoke and it will be almost impossible to see the actual seat of the fire. If the fire-fighter, however, then approaches the fire by crawling or crouching he will be able to breathe the clearer air near the deck and see the seat of the fire more easily, and by keeping low down he will also find the heat given off by the fire much less intense.

Smoke can be driven off by a wide curtain of spray from a jet/spray nozzle, *provided that the smoke is driven towards an outlet*. When driving smoke in this way it will also be found that fresh air can be breathed by keeping your face close behind the nozzle.

It must be remembered that fire often gives off poisonous gases, and that as it always uses oxygen rapidly there may be insufficient air for breathing. If smoke and fumes are dense breathing apparatus must therefore be worn.

Protective Clothing

The fire-fighter should always be completely clothed, and his face and hands must also be covered for protection against the heat. Additional protection is afforded if the clothing is first dampened and, when possible, kept damp by spray. Fearnought suits and anti-flash hoods and gauntlets are supplied for fire parties, and the manning of the branch pipes at the fire should be taken over as soon as possible by men fully clothed with this gear.

Cover

Attacking the fire from low down is a relief from exposure to the heat, and for further protection advantage should also be taken of any bulkheads or lockers.

Cooling Adjacent Compartments

While the actual fire is being tackled the fact that anything in its vicinity is also endangered must be borne in mind (see Fig. 45). Adjacent compartments, bulkheads and decks should be inspected and cleared of inflammable material, and if necessary be cooled with spray.

PORTABLE AND MOBILE FIRE-FIGHTING APPLIANCES

Hand Extinguishers

Three types of hand extinguishers are provided in H.M. ships, (i) gas/water (painted black), (ii) two-gallon foam (painted pale cream), and (iii) carbon tetrachloride, quart size (unpainted). The method of operating each is shown in Figs. 46, 47 and 48, and their working, re-charging and maintenance is described below.

GAS/WATER TYPE

This consists of an outer container holding *fresh* water, into which is placed a steel cylinder charged with carbon dioxide (CO_2) under pressure. The screwed head of the cylinder carries a piercer, which can be forced down by



Fig. 46.—Gas/Water extinguisher (inset— CO_2 charge)

striking the knob on the top ; this punctures a disc in the top of the CO_2 charge, thus releasing the gas which creates a pressure in the outer container and forces the water out through the rubber discharge hose.

To recharge, remove the screwed head and the spent charge. Refill the outer container with *fresh* water, fit a new charge and replace the head, screwing the head down as tightly as possible *by hand*. This operation is so simple and speedy that, with only two extinguishers and a constant supply of fresh water and charges, it can be continued indefinitely and without interruption.

Very little maintenance is necessary. To check the carbon dioxide charge remove it and shake it up and down ; if the pressure has dropped a tell-tale device inside will rattle and a fresh charge should be substituted. When charges are at the correct pressure no rattle should be heard when they are shaken.

Remember that the extinguisher must be filled with *fresh* water only.

TWO-GALLON FOAM TYPE

This extinguisher produces a chemical foam by mixing two liquids which react with one another, and it should not be confused with the foam units mentioned later on.

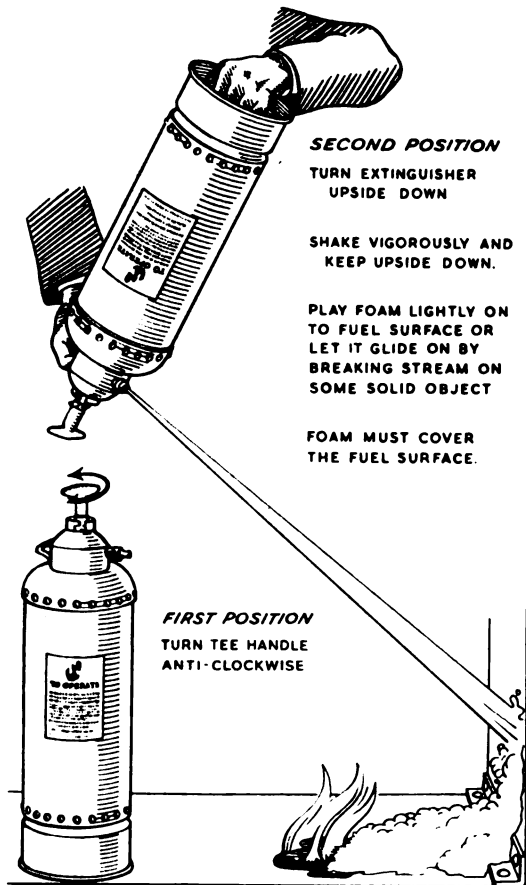


Fig. 47.—Two-gallon foam extinguisher

It consists of an outer cylinder containing a solution of bicarbonate of soda, and an inner cylinder containing a solution of aluminium sulphate. These liquids are prevented from mixing or spilling before operation by being sealed with two rubber valves coupled together. When the operator releases the "T" handle in the cap the sealing valves are lifted; then, when the extinguisher is turned upside down and shaken, the liquids mix and form foam, which is discharged from the nozzle.

Recharging this extinguisher is a tedious operation. The refills are supplied, in powder form, in yellow and blue tins for the outer and inner cylinders respectively, and complete instructions for the refilling operation are printed on the tins. When the cylinders have been recharged and replaced the cap should be screwed on with the "T" handle in the released or open position. When the cap is firmly screwed down the "T" handle is pressed down and locked in the closed position.

These extinguishers should be inspected and the liquids tested every six months, because the chemicals deteriorate with time. This is done by dipping out specified quantities with special measures supplied. The foam resulting from mixing these liquids should nearly fill a half-pint measure ; if it does not the extinguisher should be recharged.

CARBON TETRACHLORIDE TYPE, QUART SIZE

In this extinguisher the pump handle is unlocked by turning the " T " handle on the top, which also releases a seal at the discharge end. The liquid is discharged by pumping with the handle ; it is decomposed by the heat of the fire and forms a heavy, dense vapour, which smothers the fire. This extinguisher must be used with care when in a confined space as the fumes given off are poisonous.

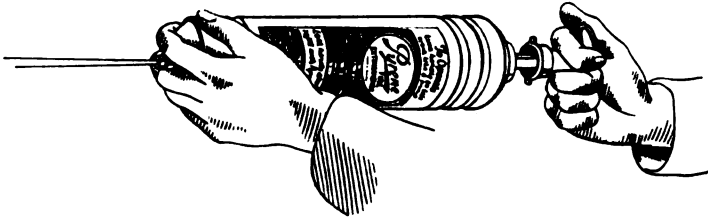


Fig. 48.—Carbon tetrachloride extinguisher

To recharge the extinguisher remove the filler cap and refill with carbon tetrachloride, which is issued in pint tins from Naval Stores.

Maintenance, inspection and refilling should always be carried out in the open air owing to the poisonous nature of the fumes arising from it. The pump should be tested regularly to ensure that it is free by placing the finger over the outlet nozzle and giving the pump a few strokes. The parts around the handle should be kept clean by occasionally wiping them over with a rag moistened with carbon tetrachloride. Care should also be taken to see that the outlet is clear.

Foam Units

Foam is a mixture of foam compound, water and air, and is used only for extinguishing burning liquids. Water pressure is essential for its production.

Every ship is supplied with at least two foam units.

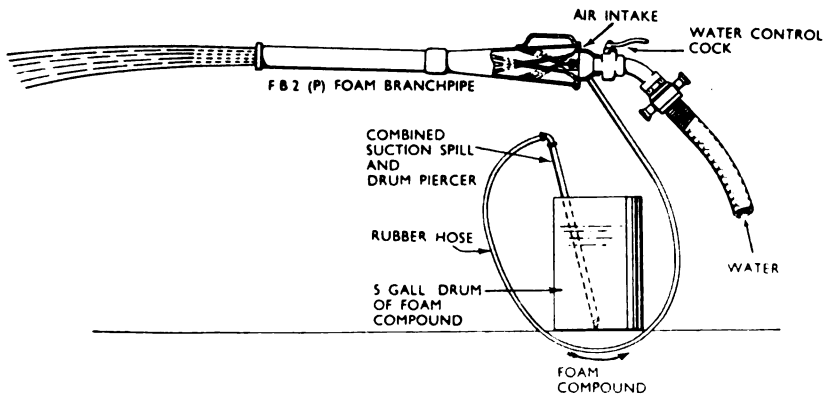


Fig. 49(a).—A foam unit

Each unit has a foam branch pipe which can be coupled to the end of a hose. Attached to the branch pipe is a rubber suction hose which ends in a steel "pick-up" tube with a sharpened end for piercing the top of a drum of foam compound. After piercing the drum the tube is dipped down into the compound and, when water pressure is opened out to the branch pipe, the foam compound mixes with the water and air, is sucked up the rubber tube and issues from the branch pipe as foam. A self-contained portable foam unit in which the drum of foam compound is strapped to the user's back is shown in Fig. 49(b).

Foam branch pipes must be stowed carefully and not be knocked about, as any damage will result in inefficient working.

CO₂ Mobile Units

These are provided in aircraft carriers for use on the flight deck and in the hangars; they consist of cylinders of CO₂, with flexible hose and distributor attached, mounted on trolleys ready for running out to a fire.

CO₂ will not burn and so can be used to smother a fire. It is therefore of great use when rescuing the crew of a burning aircraft to afford the rescuers some protection against the flames. The outfit only lasts about 50 seconds before it requires recharging, and a shut-off cock is fitted on the distributor to avoid wastage.

Portable Pumps

Most ships are provided with one or more diesel-driven, portable pumps, for use when the firemain is damaged or when normal power supplies fail. They take their suction from the sea through a pipe led through the ship's bottom; each can supply two hoses for fire-fighting.

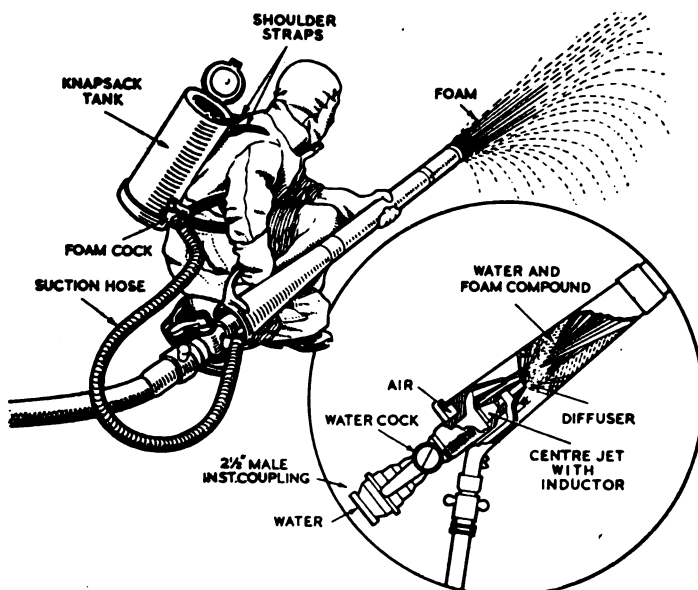


Fig. 49(b).—A self-contained portable foam unit

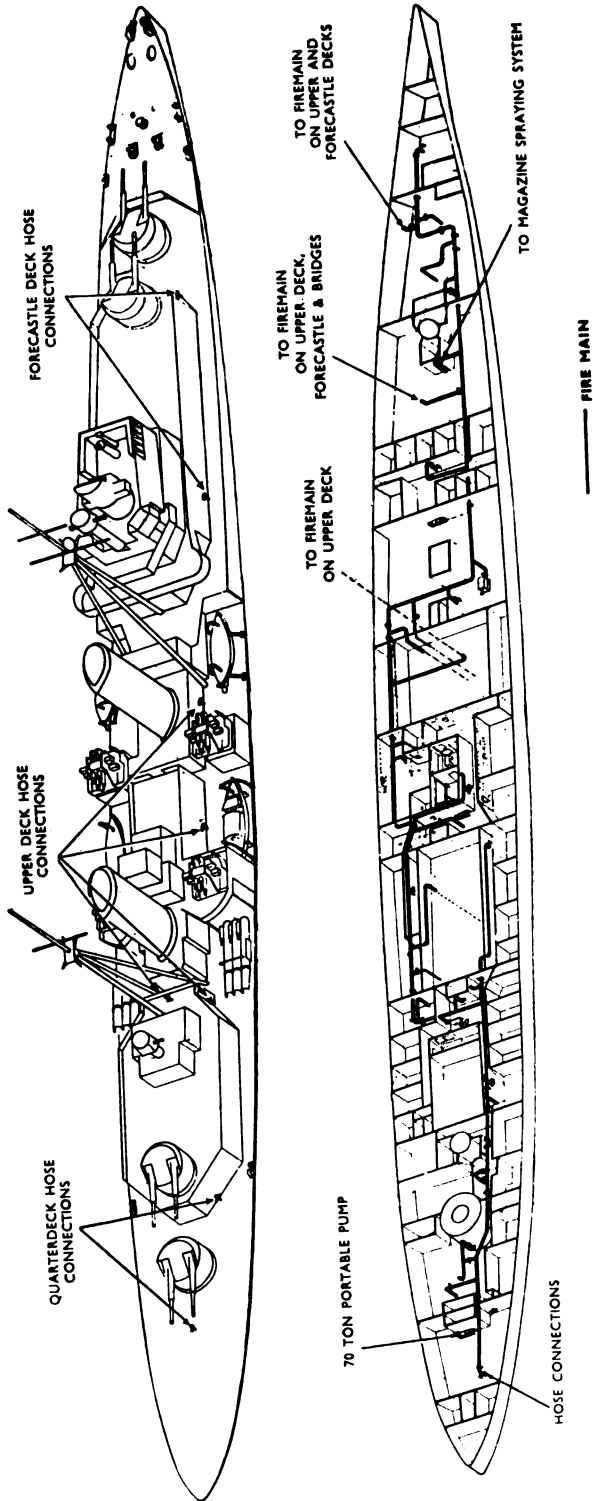


Fig. 50.—Firemain system of a cruiser

Small ships are provided with two-man, manual (*i.e.*, hand-operated) pumps for use in similar emergencies (see Fig. 51).

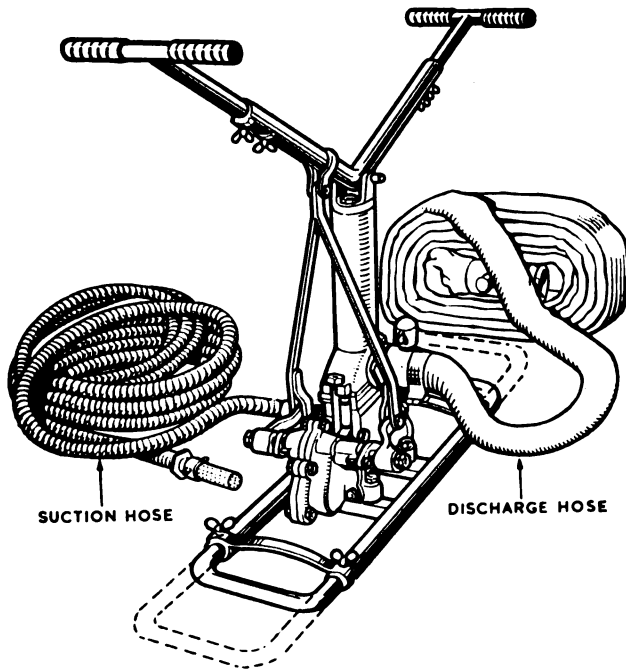


Fig. 51.—Two-man manual pump

Electrically driven portable salvage pumps may also be used in emergency.

FIRE-FIGHTING INSTALLATIONS

The Firemain System (Fig. 50)

This is the system of piping by which sea water under pressure is supplied to all parts of the ship. It is easily distinguished from other pipe systems because it is painted bright red throughout. Pumps situated between decks supply the sea water under pressure, and the system is usually divided by stop valves into several sections, each with its own pumps, so that if one section is damaged the remainder of the system can still be used (see Fig. 52).

When fire-fighting it must be remembered that only a limited number of hoses can be used on one section, otherwise the capacity of the pumps connected will be exceeded so that the pressure in the hoses becomes insufficient for their jets to reach the fire. As a rough guide not more than three hoses should be used on any one section without the advice of A.B.C.D. Headquarters, or of somebody who knows the state of the firemain. Extra pumps can be started, or other sections of the firemain be isolated, to boost the supply to the section in use.

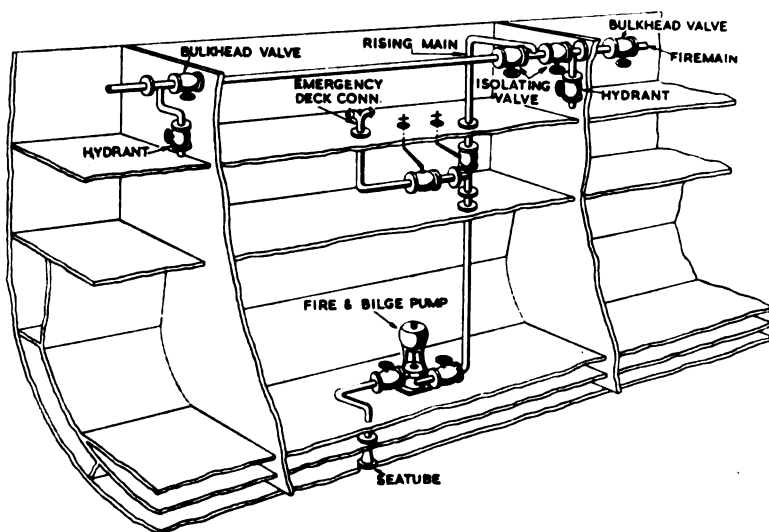


Fig. 52.—Typical section of a ship's firemain

If one section of the firemain is damaged a temporary supply of water can be obtained by isolating that section by shutting the isolating stop valves concerned, and then connecting the hydrants on either side of the section by canvas hose (see Fig. 53).

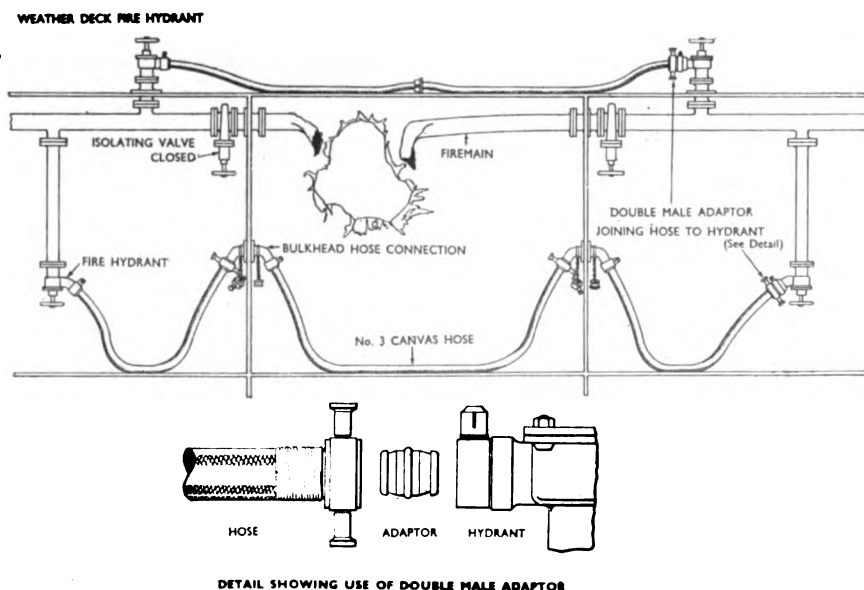


Fig. 53.—Typical arrangement of re-instatement of firemain with canvas hose

HYDRANTS

These branches from the main firemain system are fitted with valves and hose connections, and are to be found in almost every main compartment of the ship. Between decks the fire hoses, with their branch pipes fitted, should be kept coupled to these hydrants and ready for instant use. Hydrants are fitted with a female coupling containing a rubber washer.

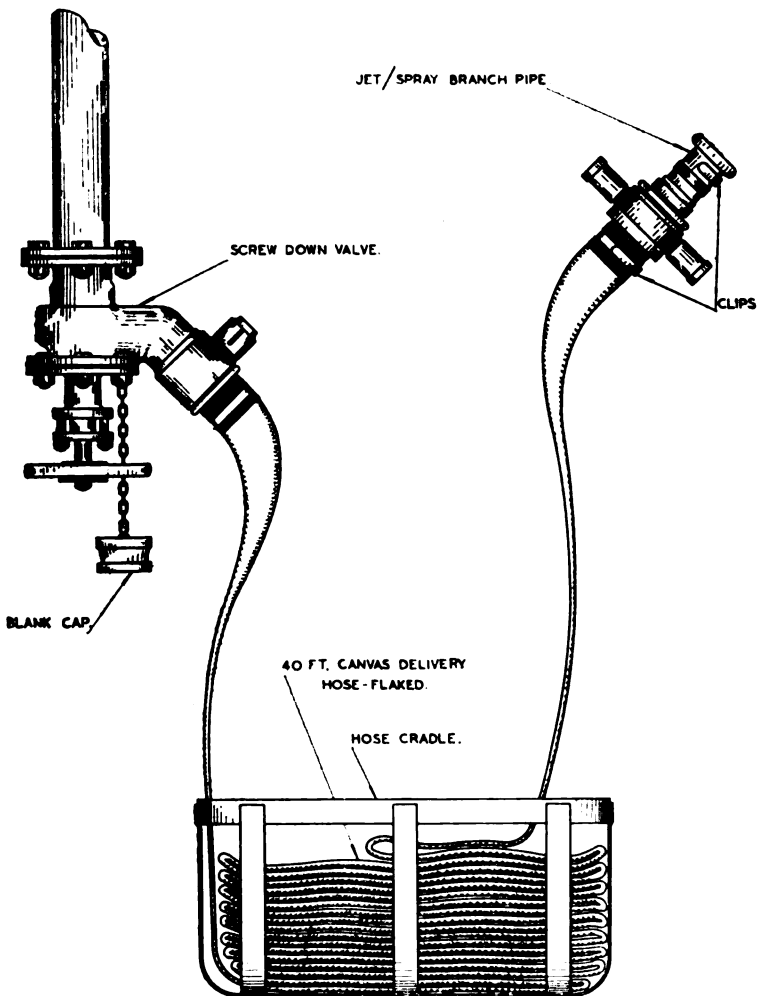


Fig. 54.—Typical arrangement of hose stowage at hydrant

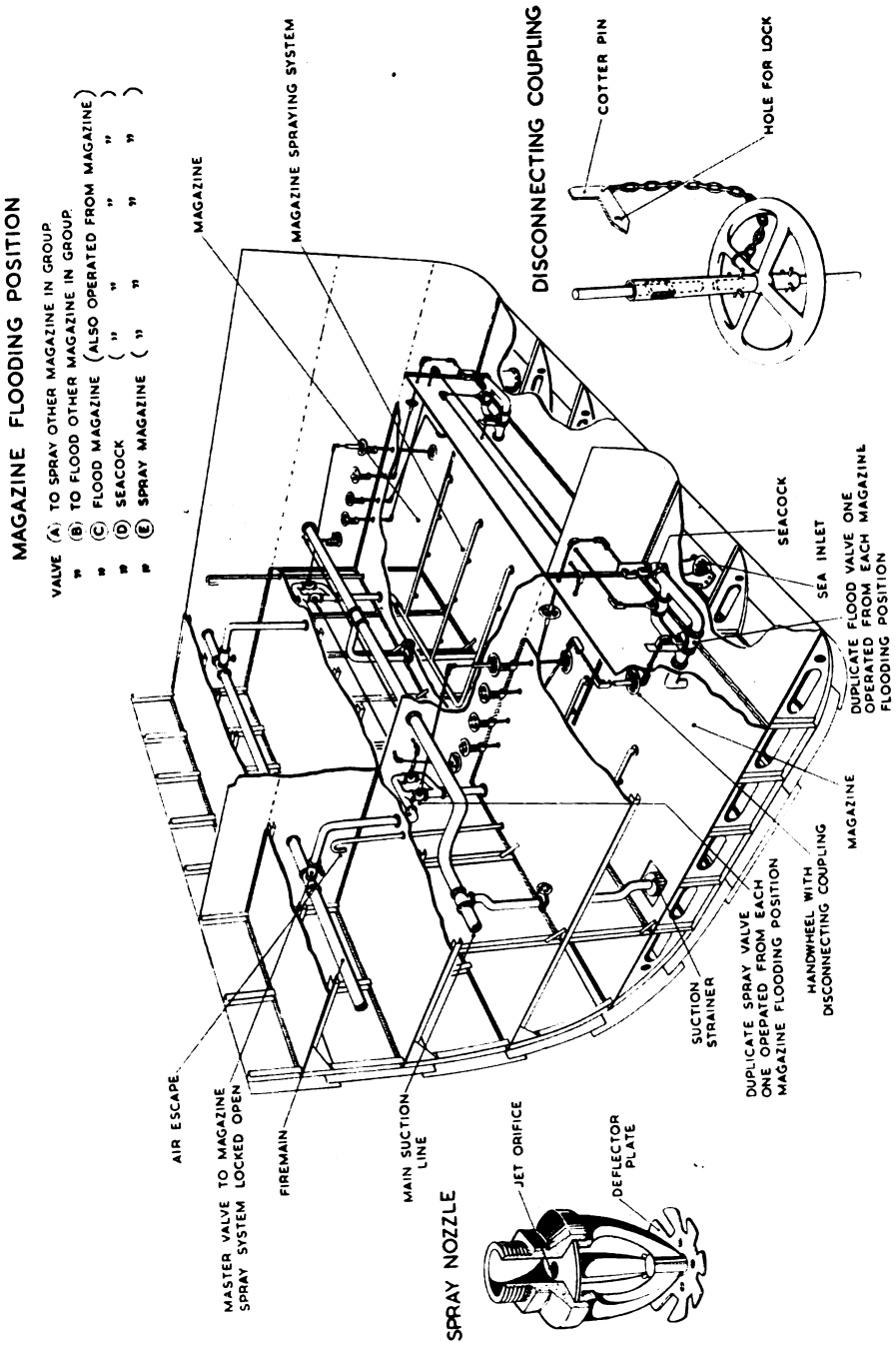


Fig. 55.—Typical magazine flooding and spraying arrangements for a group of magazines

Hoses

Canvas hoses are supplied for, and should be kept connected to, every hydrant throughout the ship. The brass couplings at their ends must not be dropped, dragged along the deck, or knocked about. The coupling at one end of the hose is male and that at the other end is female; the male coupling should always be connected to the hydrant, and the female end of the hose taken to the fire. The joints in the coupling are made water-tight with rubber washers, which must be inspected regularly and maintained in good order.

Hoses being made of canvas are easily damaged, and the following points in regard to their treatment should always be observed :—

- (i) hoses (and couplings) should not be painted, even with “duresco”;
- (ii) hoses should not be washed with strong soda;
- (iii) they should not be left flaked or rolled for too long without opening them out for inspection;
- (iv) oil or grease should not be spilt on them;
- (v) they should be thoroughly dried before stowing, otherwise they will rot in their stowage;
- (vi) fire hoses should not be used for washing decks;
- (vii) to expel the water from a hose it should not be walked upon along the deck, but should be under-run at shoulder height;
- (viii) hoses should be flaked or rolled in their stowages ready for running out (see Fig. 54).

Nozzles

Two types of nozzles (branch pipes) are supplied to H.M. ships, namely the jet-spray and the “Oilfyre”.

Jet-spray nozzles are provided for all general purposes; they produce a jet or spray, and can be shut off completely by twisting a sleeve on the body.

“Oilfyre” nozzles are supplied chiefly for spaces such as boiler rooms where oil fires are likely to occur. They produce a spray only.

Care must be taken not to damage nozzles, and they must never be used as hammers or levers.

Flooding

Fixed flooding arrangements are fitted to shell rooms, spirit rooms, inflammable stores and certain magazines, so that they may be flooded directly from the sea should fire break out in or near these compartments. Flooding valves can be operated either from the immediate vicinity of the compartment, or from positions remotely above them.

Magazine Spraying

Magazines are fitted with a spray system which is led off the firemain. Spraying is quicker than flooding, and as it is much less drastic the cordite charges are only dampened and so can be recovered afterwards. When flooding a magazine it is advisable to spray at the same time, thus damping down the upper charges while flooding is in progress. Sprays can be operated from inside the magazine, or by remote control from above (see Fig. 55). A similar spraying arrangement is provided for petrol control compartments.

Hangar Spraying

The hangars of aircraft carriers are fitted with quick-acting spraying arrangements which are operated from the hangar lobbies. Water is supplied to these sprays by special, high-capacity pumps, which are started simultaneously when it is desired to spray the hangar. Hangars are sprayed in sections, but all sections of the hangar may be sprayed together if required.

When the spray is operated in a closed hangar so little air reaches the fire that it is smothered, and the fire is thus prevented from spreading. Hangars can be divided into sections and separated from the lift wells by asbestos curtains; these are lowered by hand, or by electric motors controlled from nearby lobbies.

Hangars are provided with large scuppers to drain away the water after spraying, *and it is important always to keep these scuppers clear and to ensure that no inflammable liquids are poured down them.*

Steam Smothering

Machinery spaces of ships are fitted with steam smothering systems, operated from outside. It is essential that the compartment should be sealed as effectively as possible before the steam is opened out. The compartment must be kept closed for some time after the steam has been shut off, to allow it to cool thoroughly and so avoid re-ignition.

Foam Inlet Tubes

Engine rooms, boiler rooms and certain other machinery compartments are fitted with tubes for supplying foam from the deck above. These tubes are so arranged that they direct the foam down to the bilges where it can flow over the surface of any burning liquid.

Methyl Bromide Systems

The machinery spaces and petrol tank compartments of petrol-engined craft are fitted with a methyl bromide system for dealing with fires which are beyond the capabilities of hand extinguishers. The methyl bromide is supplied from cylinders fitted in the engine room and is released by operating gear from either of two positions, one near the hatch of the engine room, the other on the bridge.

Methyl bromide gas is poisonous to breathe and, under certain conditions, it blisters the skin. Any man exposed to it must be given medical attention.

AUXILIARY FIRE-FIGHTING EQUIPMENT

HAND TORCHES

These are provided in fire and damage control lockers for use in emergency; they must be maintained in good order and must not be used for any other purpose.

HEADLAMPS

These battery-operated lamps are strapped to the forehead, thus leaving both hands free. The batteries must be recharged and tested frequently.

FLOODLIGHTS

These are supplied for emergency lighting and can be connected to any supply box by a long flexible lead. They should only be connected by electrical ratings.

PORTABLE BATTERY-OPERATED FLOODLIGHTS

These are supplied for use when the normal ship's lighting has been put out of action. Their primary use is for providing lighting in the vicinity of a fire, or for repair operations, while emergency lighting is being rigged. The lamp is similar to a car headlamp and is mounted with a swivel connection on the top of the battery case. The battery will give a strong light for several hours.

FEARNOUGHT SUITS, ANTI-FLASH HOODS AND GAUNTLETS

These are provided in the fire lockers and should be worn for protection from heat when fire-fighting.

SAND

Bins of sand are provided at various places about the ship, particularly where liquid fuel fires are likely to occur. Sand is used to absorb the liquids and prevent slipping on oily decks.

BREATHING APPARATUS

Two types of breathing apparatus are provided and stowed around the ship ready for use.

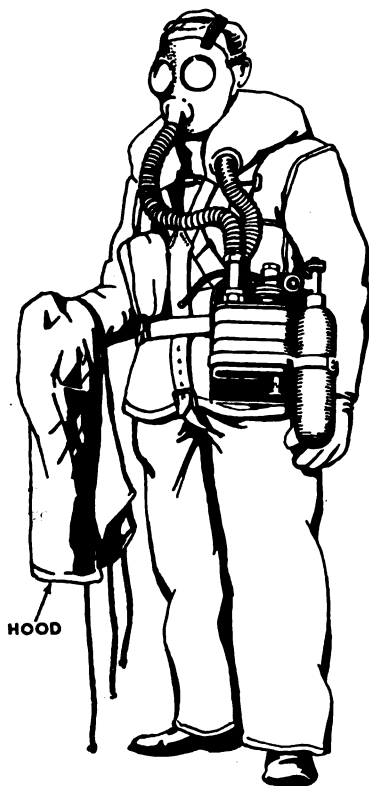
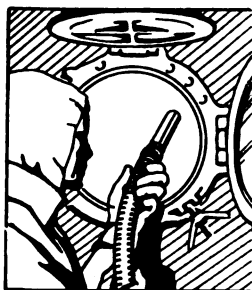


Fig. 56.—"Salvus"
Breathing Apparatus



Inset shows method
of tending hose
to supply fresh air.

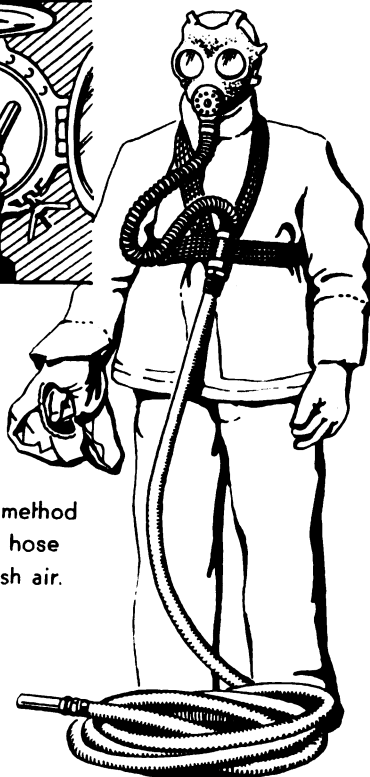


Fig. 57.—Patt. 230
Breathing Apparatus

The "Salvus" and the *Compressed Air Breathing Apparatus*. These are completely self-contained. The former (see Fig. 56), supplies oxygen and purifies the air breathed within the set; the latter supplies fresh air from bottles. Each lasts for three-quarters of an hour or more without recharging.

Pattern 230 Breathing Apparatus (see Fig. 57). This consists of a face-piece connected to a long tube which supplies fresh air from outside the compartment to the wearer. This type is very simple to use, but the long tube may hamper the movements of the wearer. A further disadvantage is that another man is required to tend the free end of the tube and ensure that fresh air is available to the wearer.

The Service anti-gas respirator must not be worn for fire-fighting except as a means of escape in extreme emergency. Although it gives limited protection against smoke, and protection against most poisonous gases, it does not provide the wearer with the oxygen which is often lacking in a fire area, particularly near a fire which intermittently gives forth volumes of smoke.

METHODS OF EXTINGUISHING FIRES

Methods of tackling different types of fires are described here. Where alternatives are given, choice must be governed by conditions such as the extent, type and situation of the fire. Ventilation should always be shut down in the vicinity of any fire unless specifically stated otherwise.

Structural and General Fires

Gas/water hand extinguishers or jet/spray nozzles should be used, and the surroundings of the fire should be cooled by spraying. Smouldering solids must be broken up and thoroughly drenched. Careful watch must be kept when the fire is apparently out, because re-ignition is likely with this type of fire.

Magazine and Shell Room Fires

These should be sprayed, or sprayed and flooded if the fire is sufficiently dangerous. Surrounding compartments should be cooled with spray.

Inflammable Liquid Fires generally

Hand foam extinguishers or main foam appliances should be used. In engine rooms and certain other machinery spaces foam tubes are fitted to direct the foam to the bilges.

Foam should not be directed at the surface of burning liquid as it will disturb the surface and scatter the burning fuel. It should be played on a vertical surface in the vicinity, whence it will run down and cover the surface of the burning fuel. Spray is effective on liquid fuel fires provided that all the surface of the burning liquid can be reached.

Oil Fuel Fires in Boiler Rooms

Hand foam extinguishers or spray nozzles should be used. Fans should be kept running to drive the smoke up the funnel. If it becomes necessary to evacuate the compartment it should either be closed down, the fans stopped, and foam poured down the foam tubes by the main foam appliances, or it should be drenched by the steam drenching system.

Petrol and other Highly Inflammable Liquids

Hand foam extinguishers or main foam appliances should be used. Spray is useful for cooling the surroundings, but should not be used on the fire itself.

Aircraft Fires on Deck

Hand foam extinguishers, or main foam appliances in conjunction with CO₂ mobile units, should be used.

Fires in Hangars

Hand foam extinguishers, or main foam appliances in conjunction with CO₂ mobile units, and, when necessary, the hangar sprays, should all be used.

Petrol Fires in Small Craft

Hand foam extinguishers or the fixed methyl bromide system should be used. Carbon tetrachloride hand extinguishers should be used for small carburettor fires. Great care must be taken when using methyl bromide or carbon tetrachloride, because of the poisonous nature of the vapour.

Electrical Fires

There is always a danger of electric current being transmitted to the fire-fighter through the extinguishing medium. The current must therefore always be switched off if possible, and the fire then be dealt with by the method best suited to the nature of the burning equipment.

If the current cannot be switched off, the gas/water hand extinguisher can be safely used on apparatus charged with the ship's normal service voltage ; it must not, however, be used on radar, W/T and asdic equipment, for which carbon tetrachloride extinguishers should be used, due regard being paid to the danger from poisonous vapour.

Sea-water jet should never be used against electrical fires, as the salt in the water makes it an electrical conductor and so renders the fire-fighter liable to lethal shock. Salt water will also damage electrical equipment.

Cinema Film Fires

The film should be allowed to burn itself out, but the surroundings should be cooled with spray and the compartment be kept ventilated.

CHAPTER IV

Internal Organisation

VOICE COMMUNICATION

THE following rules should be observed when using a telephone, voice-pipe, broadcaster, loud-hailer, or other similar method of communication :—

- (i) make up your mind what you are going to say before you say it ;
- (ii) read to yourself any written message before passing it verbally ;
- (iii) speak clearly and deliberately ;
- (iv) spell proper names by the phonetic alphabet if there can be any doubt about their correct reception ;
- (v) transmit important groups of numbers singly and phonetically ;
- (vi) always make your message as brief as possible.

Methods of Internal Communication

The principal means of conveying orders and information within a ship or establishment are by :—

- (i) messenger ;
- (ii) telephone ;
- (iii) voice pipe ;
- (iv) broadcasting (warning telephone (Wa/T) system).

MESSENGER DUTIES

A messenger should know all the officers and senior ratings by name or title, and he should know the “ geography ” of his ship.

He should deliver his messages as quickly as possible, by the shortest route. When delivering a message he has right of way anywhere ; for example, he should not hesitate to enter the quarters of a senior officer when he has a message for him.

When given an important verbal message the messenger may be ordered to repeat it back as a means of checking that he will deliver it correctly. If a messenger does not clearly understand the message he is to deliver, he must at once ask for it to be repeated ; a smart “ getaway ” will in no way redound to his credit when he is reported for delivering it incorrectly, and incorrect messages may have serious results in naval life.

On receiving a written message the messenger must make sure that he understands to whom it is to be delivered, and whether or not he is to bring back a reply.

On first approaching an officer a messenger should address him by his official title, or by his rank and name, *e.g.*, “ Commander (E), Sir ”, or “ Lieutenant Jones, Sir ”, he should wait until the officer is ready to receive the message, then deliver it, and then wait for a reply, an acknowledgment, or his dismissal, before carrying on.

If for any reason a messenger is unable to deliver his message, he must immediately report the fact to the originator of the message.

HOW TO USE THE TELEPHONE

The telephone is a delicate instrument and should always be handled and replaced with care. Rules for using it are given below.

- (i) Speak directly into and close to the mouthpiece.
- (ii) When calling ask whenever possible for the number required, and not for the person.
- (iii) When connected state who you are and with whom you wish to speak—*do not say "Hullo"*.
- (iv) When replying state who you are and from where you are speaking—*do not say "Hullo"*.
- (v) When replying identify the caller before continuing the conversation.
- (vi) When using a shore circuit make sure you are connected with the right person before discussing any Service matter.
- (vii) Remember that a telephone system is never safe from eavesdroppers, so do not discuss confidential matters over it.
- (viii) If you are disconnected in the middle of a conversation it is the responsibility of the caller to re-establish conversation; the person called should wait for half a minute before abandoning the call and replacing his receiver.
- (ix) To transfer a call to another number on the same exchange recall the operator by depressing the receiver rest at intervals of about two seconds.
- (x) Wait at least a quarter of a minute before making a fresh call.

HOW TO USE THE VOICE PIPE

The rules for using a voice pipe are as follows :—

- (i) to make a call press the call push (if provided) ;
- (ii) speak loudly and directly into the mouthpiece ;
- (iii) when calling, first state the name of the position you wish to speak to and then the name of the position from where you are speaking ; when answering, first state the position from which you are speaking, and then the position to which you are speaking.

HOW TO USE THE WARNING TELEPHONE BROADCASTING SYSTEM (Figs. 58 and 59)

The normal method of transmitting orders and information throughout a ship or establishment is by warning telephone broadcast (Wa/T) through loud-speakers operated from a control position, and this system also provides for the transmission of an alarm signal such as "Fire" or "Attack". Where the system is not fitted, "pipes" have to be relayed throughout the ship by boatswain's mates and call-boys.

The rules for using a broadcast system are given below.

- (i) Speak across the microphone from a distance of about four inches, not directly into it.
- (ii) Speak in a loud conversational tone, but *do not shout* ; the brilliance of the indicating lamps is a good guide—they should just flicker.
- (iii) When piping, blow the call as close as possible to the microphone.
- (iv) A bugle call should be made with the bugle not nearer than three feet from the microphone, and with the bugle directed across it, not into it.

- (v) The broadcaster should be used only for routine calls, and for important calls out of routine ; it should never be used needlessly, or when a messenger would serve equally well.
- (vi) Calls should be broadcast only on the required circuit , see therefore that the operating key is in the correct position.

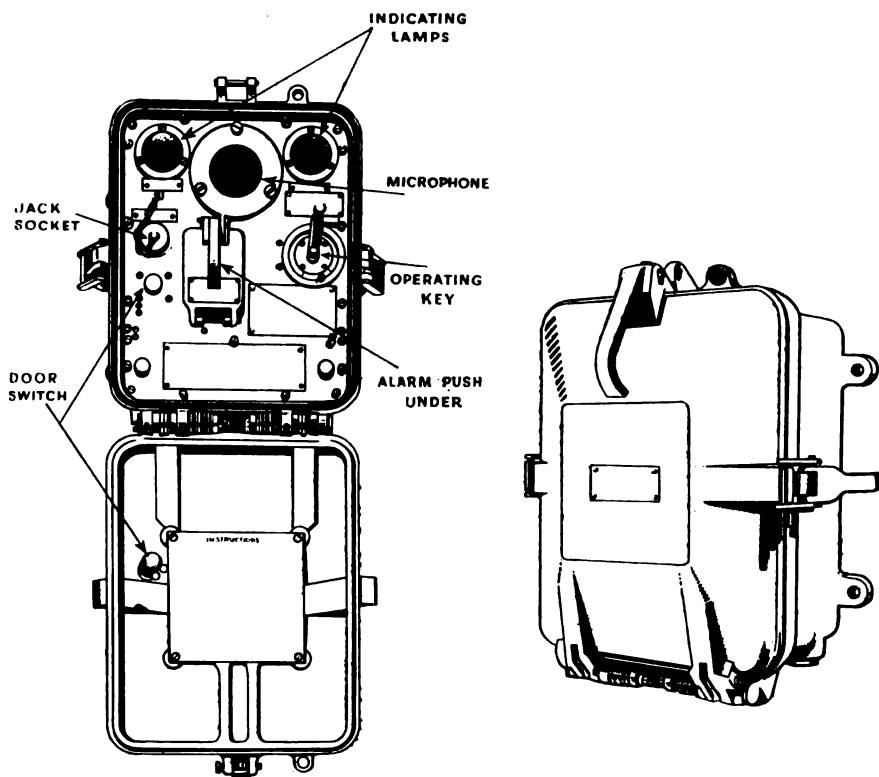


Fig. 58.—A broadcast control box

Provision is made for the connection of four control boxes. Two of these are normally under the direct control of the Officer of the Watch, being situated one on the quarterdeck and one on the bridge, and operated by the quarter-master's staff. Each control box (Fig. 58) contains :—

- (i) a *door switch*, which automatically brings the sound amplifier into operation when the box is opened ;
- (ii) a *microphone* ;
- (iii) an *operating key* for switching on the microphone and connecting it with the required group of loud-speakers ; when in the first operating position it cuts out the officers' group of loud speakers ;
- (iv) an *alarm push*, which causes a harsh warning note to be reproduced by the loud-speakers ; it has a hinged cover, and a switch which when made connects the officer's group of loud-speakers whatever the position of the operating key ;

- (v) *indicating lamps* which light up when the amplifiers are operating, and whose brilliance indicates the volume of sound being transmitted ; these lamps also light up if the system is already in use from another control box ;
- (vi) a *jack* (i.e., plug), with which a portable microphone can be connected for broadcasting from a position at a distance from the control box.

To broadcast from a control box the following procedure should be carried out :—

- (i) open the door of the control box ; if the equipment is already in use from another control box the indicating lamps will flicker ; if the indicating lamps show that another control position is breaking in, or if some other broadcast is heard on an adjacent loud speaker, the operating switch should be released immediately ;
- (ii) move the operating key to the position required ; it is self-locking in each position, and is released by pressing the central knob ;
- (iii) after making the call, release the operating key and close the door of the control box.

To make an alarm signal from the control box :—

- (i) open the door of the control box ;
- (ii) open the cover of the alarm push ;
- (iii) operate the alarm push as required ; it is *not* necessary to move the operating key ;
- (iv) on conclusion of the alarm signal, close the latch and cover of the alarm push ;
- (v) close the cover of the control box.

To make an alarm signal from an extension alarm push (see Fig. 59) :—

- (i) make the barrel switch to the *on* position ;
- (ii) operate the alarm push as required for the alarm ordered ;
- (iii) put the barrel switch to the *off* position.

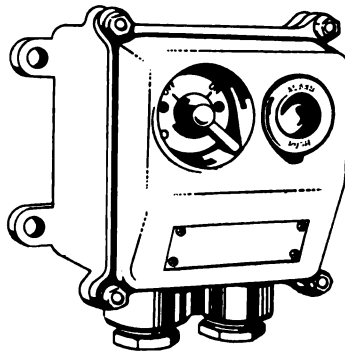


Fig. 59.—An extension alarm push

Telephone Systems

There are usually three different types of telephone systems in modern warships, namely : " Direct systems ", " Exchange systems ", and " Group systems ".

A direct telephone links two positions together, and there is no fear of outside interference when making a call.

In an exchange system several positions are connected to an " exchange " where, by means of a switch board, any one position can be connected to any other in the system. Calls made through this system are liable to interference.

In the group system several positions are connected in groups to a " controlling position " from which orders may be passed simultaneously to all

positions; any replies made can be overheard by each position. This is effected by means of an exchange, or a control box, or the positions can be permanently inter-connected. A controlling position is essential to avoid confusion arising from several persons speaking simultaneously.

The different telephone systems usually fitted in a warship are as follows :—

- (i) *The Main Exchange*, the chief telephone system of the ship, used for all general communication. Its switchboard is manned continuously, day and night, by operators called "telephone watchkeepers". This system can be connected to a shore exchange system when the ship is berthed alongside in harbour, or when moored to a buoy which has a telephone cable from the shore system already laid to it.

Main exchange telephones are distinguished by a tally plate on which is marked the letter "M" followed by the number of the telephone and its position.

- (ii) *The Engine Room Exchange*, a small exchange system used for communication between the engine and boiler rooms.
- (iii) *The Fire Control Exchange*, used only for communications concerned with the control of the gun armament of the ship. It can be used either as a group or an exchange system.

A fire control exchange telephone is distinguished by a tally plate bearing the letter "G" followed by its position.

- (iv) *Direct Telephones*, which are used for many purposes. A direct telephone, is distinguished by a tally plate bearing the letter "D" followed by the position to which it is connected; if used solely in connection with the ship's armament the letter "D" is followed by the letter "A".
- (v) *Damage Control Telephones*, which are usually connected on the group system, but may also be connected with either the exchange or the direct systems.

There are three types of damage control telephone, and they are distinguished from each other by the colours of their hand-sets, which are :—

- for fire-fighting and general damage ... Red;
- for electrical damage and repairs ... Green;
- for pumping and flooding ... Yellow.

The three different types of telephone instruments fitted in H.M. ships are described below.

- (i) *Hand-sets*, similar to those installed on shore, but more robustly made. Lifting the handset of one of these automatically calls the exchange, or, if in a direct system, the particular instrument with which it is connected.
- (ii) *Head-sets*, comprising earphones and, usually, a transmitter. They are fitted with long flexible leads which can be plugged into sockets fitted in the required positions and connected with the permanent wiring of the system. Such telephones are generally used in the Fire Control system.
- (iii) *Hand-sets fitted with a hand generator call-up*. This generator is operated by turning a handle. These may be equipped with a lamp which burns when the call-up is operated.

Broadcast Systems

These amplify the voice reproduced by a microphone and relay it to several other positions simultaneously through loud-speakers. Three examples of broadcast systems are :—

- (i) *The Warning Telephone System*, which is the main broadcast system of a ship ;
- (ii) *The Armament Broadcast System*, by which orders and instructions are relayed during action to the various armament positions of the ship ;
- (iii) *Loud Hailers*, which are used for verbal communication between ship and ship or between ship and shore ; they considerably amplify the voice and are now used instead of the megaphone.

ORGANISATION

The term organisation covers the allocation of officers and men for the various duties required of them, both by day and night, for the working, maintenance and fighting of their ship and her equipment in the most efficient manner possible. It also includes the arranging of routines, the manning of the armament, the berthing, messing and victualling of the ship's company, and the division of the latter into watches, parts-of-ship, and divisions.

Details of organisation vary in each type of ship, because they depend upon her armament and the functions she is expected to perform ; the general principles, however, are the same throughout the Royal Navy and are explained in the following pages.

Allocation of the Hands for Routine and Special Work

The necessary number of hands required for carrying out the various routine and special duties in a ship are summoned to muster, or to carry out a specific duty, by certain recognised bugle calls or pipes ; these are explained below.

" Clear lower deck ". This calls all men of all branches, except those men actually on watch.

" All the hands ". Formerly, this call meant the same as the present-day *" Clear Lower Deck "*, but now it calls all seamen and marines only, except those actually on watch.

" Watch of the hands " or *" Part of the watch of the hands "*. These call all seamen and marines of the watch or part designated, except those actually on watch.

" Both watches for exercise ", *" Watch for exercise "*, *" Part of the watch for exercise "* or *" Sub-division for exercise "*. These call all the seamen and marines of the watches, watch, part of watch or sub. of watch, as designated, except those men on watch and those shown on the *" Excused list "*.

The call *" Clear lower deck "*, when made in working hours, interrupts the whole routine work of the ship and so is usually reserved for emergencies, or for routine general musters—such as the muster for payment.

The calls *" All the hands "*, *" Watch of the hands "*, and *" Part of the watch of the hands "* are usually reserved for the main musters of the day, drills or evolutions, and for work for which the normal watch or part is insufficient. It should be borne in mind that, in working hours, these calls take special duty-men and training classes away from their work.

DEGREES OF READINESS

DEGREE OF READINESS	STATION	PROPORTION OF CREW CLOSED UP AT THEIR QUARTERS	STATE OF ARMAMENT, AND CIRCUMSTANCES
<i>First Degree</i>	Action Stations	All Hands	Complete readiness for immediate action. Action with enemy forces imminent.
<i>Second Degree</i>	Action Stations relaxed	All hands, except a small proportion from each quarter who are allowed to fall out for meals or relax at their action stations.	Temporary relaxation from <i>First Degree</i> . Action with enemy less imminent or a lull in an engagement.
<i>Third Degree</i>	Defence Stations	One watch or a part of a watch, according to the proportion of the armament required to be manned, which in turn is governed by the degree of threat from the enemy surface forces, aircraft or submarines.	A proportion of the armament ready for immediate action, the remainder at short notice; the watch not closed up carry out normal routine duties with their parts-of-ship. Action with enemy possible but not imminent.
<i>Fourth Degree</i>	Cruising Stations	A part of a watch, or a proportion of a part of a watch.	A smaller proportion of the armament ready for immediate action, the remainder at prolonged notice; normal ship's duties are carried out by men not closed up at quarters, hands working with their parts-of-ship. Action with enemy possible, but fairly remote.

EXAMPLES OF QUARTERS ORGANISATION FOR A DESTROYER

Armament: two twin 4-inch mountings (A & B) with control positions and transmitting station (T.S.), miscellaneous close-range weapons (C.R.), torpedo tubes and anti-submarine weapons (T. A/S).

THREE WATCHES—3RD OR 4TH DEGREE OF READINESS

PART-OF-SHIP	WATCHES		
	RED	WHITE	BLUE
Forecastle	1/3 A 1/3 T.S.	1/3 A 1/3 T.S.	1/3 A 1/3 T.S.
Top	1/3 B 1/3 T.A/S.	1/3 B 1/3 T.A/S.	1/3 B 1/3 T.A/S.
Quarterdeck	1/3 C.R.	1/3 C.R.	1/3 C.R.

TWO OR FOUR WATCHES—3RD OR 4TH DEGREE OF READINESS

PART-OF-SHIP	PARTS OF WATCHES			
	1ST PORT	1ST STARB.	2ND PORT	2ND STARB.
Forecastle	1/4 A 1/4 T.S.	1/4 A 1/4 T.S.	1/4 A 1/4 T.S.	1/4 A 1/4 T.S.
Top	1/4 B. 1/4 T.A/S.	1/4 B. 1/4 T.A/S.	1/4 B. 1/4 T.A/S.	1/4 B. 1/4 T.A/S.
Quarterdeck	1/4 C.R.	1/4 C.R.	1/4 C.R.	1/4 C.R.

If a comparatively small number of hands is unexpectedly required during working hours, "Hands working on the upper deck" is usually piped instead of the watch or part of the watch, so as to avoid unnecessarily interrupting the work of the ship and the training classes.

Quarters

In war, different circumstances require that the whole, or only a portion, of the armament of a warship be kept manned and ready for instant action. The manning of her armament is therefore based on the watch system, so that the whole or only a portion of the ship's company are at their quarters according to the "degree of readiness" required by the existing circumstances.

There are four different degrees of readiness, as described in the table on the opposite page, under which all hands, a watch, two watches, or a part of the watch, are kept closed up at their action stations.

A man's action station, or "quarter", is that part of the armament of a ship to which he is detailed for fighting duties. The quarter to which he is assigned may vary with the degree of readiness for action which is in force.

A watch or part of a watch includes not only a balanced proportion of petty officers and men from each part-of-ship, but also a balanced proportion of the hands necessary for manning and fighting a portion of the armament. To illustrate how watches and parts of watches, parts-of-ship and quarters fit together in the quarters organisation of a ship, simplified examples of watch organisations for a destroyer are shown on the opposite page.

Watch and Station Bill

Every member of the crew, in addition to being detailed for specific routine duties and ship work, is allocated to specific quarters for fighting the ship, and to special stations for certain emergencies.

Every seaman is detailed in a *Watch and Station Bill* for his station for quarters and for certain general evolutions (see Fig. 60). The Watch and Station Bill is a printed broadsheet, ruled in columns, in which is entered the name of every member of the seaman branch, together with his Ship's Book number, his quarters for each degree of readiness, his emergency boat station, his special duty (if any), and his watch, part of watch, sub-division (if any) and part-of-ship.

The other branches or departments also each have a watch and station bill in which are entered the stations, watches, and special duties of their men.

Copies of these Watch and Station Bills are posted on the ship's main notice boards, and a man can find from them at a glance his more important stations. Detailed orders for other evolutions are usually included in a separate station bill, issued by the Executive Officer, in which men are detailed by watch or part-of-ship.

QUARTER DECK	1st PORT											
	NAME	RATING	NON SUB	MESS	LOCKER No.	HAMMOCK STOW	SPECIAL DUTY	ACTION STATIONS	DEFENCE STATIONS	CRUISING STATIONS	BOAT STATION	EMERGENCY STATION
	1 SMITH	WTR	—	25	135	FORE MESS DECK	CAPT'S OFFICE	"B" SHELL	"B" SHELL	CAPT'S OFFICE	1st MB	—
	3 GREY											
	5 BLOGG J.B.	A/B	LR II	21	123	STBD X PASS	PO'S MESS	AGL. TURRET	GL. A	GL. B	2nd CUTTER	BOTTOM LINE
	7 BROWN											
	9 JONES B.J.	STO	—	33	49	STO'S DECK	UPPER DECK	FORE REPAIR PARTY	"A" BOILER ROOM	UPPER DECK	1st WHALER	—

Fig. 60.—Excerpt from a Watch and Station Bill

Duty Watches

Depending upon their size and general arrangements, ships' companies work in two, three, or four duty watches, or sometimes part of the ship's company works under one system and part under another. An example of the latter was that in the Second World War (1939–45), when, at sea, some ships had the manning of their armament organised in two or four watches, according to the threat of air, surface or underwater attack, but the lookouts, navigation party and others worked in a regular three watches; and when in harbour everybody reverted to four watches throughout.

At sea the duty part of the watch changes at the end of each watch, *i.e.* every four hours (two hours in the dog watches), but in harbour the duty part changes every 24 hours only, at 12.30.

Whichever watch system is adopted it is convenient to maintain a regular sequence of watches, and for this a roster is useful. An example of a roster which caters for each system is given on the opposite page.

It may be memorised if it is noted that :—

- (i) if the ship proceeds to sea and so changes the duty watch every 4 hours instead of every 24, the duty part in harbour has the afternoon watch at sea;
- (ii) conversely, if the ship returns to harbour, the party detailed for the afternoon watch at sea becomes the duty part for that day in harbour;
- (iii) the sequence for coloured watches, both at sea and in harbour, is red, white and blue;
- (iv) the sequence for parts of the watch at sea is 1st of port, 1st of starboard, 2nd of port, and 2nd of starboard, whereas in harbour it is 1st of starboard, 1st of port, 2nd of starboard and 2nd of port (vide the afternoon watch column).

DUTY WATCH ROSTER

	MIDDLE	MORN- ING	FORE- NOON	AFTER- NOON	1ST DOG	LAST DOG	FIRST
Aug. 24, Sept. 5	1 P Red	1 S White	2 P Blue	2 S Red	1 P White	1 S Blue	2 P Red
Aug. 25, Sept. 6	2 S White	1 P Blue	1 S Red	2 P White	2 S Blue	1 P Red	1 S White
Aug. 26, Sept. 7	2 P Blue	2 S Red	1 P White	1 S Blue	2 P Red	2 S White	1 P Blue
Aug. 27, Sept. 8	1 S Red	2 P White	2 S Blue	1 P Red	1 S White	2 P Blue	2 S Red
Aug. 28, Sept. 9	1 P White	1 S Blue	2 P Red	2 S White	1 P Blue	1 S Red	2 P White
Aug. 29, Sept. 10	2 S Blue	1 P Red	1 S White	2 P Blue	2 S Red	1 P White	1 S Blue
Aug. 30, Sept. 11	2 P Red	2 S White	1 P Blue	1 S Red	2 P White	2 S Blue	1 P Red
Aug. 31, Sept. 12	1 S White	2 P Blue	2 S Red	1 P White	1 S Blue	2 P Red	2 S White
Sept. 1, Sept. 13	1 P Blue	1 S Red	2 P White	2 S Blue	1 P Red	1 S White	2 P Blue
Sept. 2, Sept. 14	2 S Red	1 P White	1 S Blue	2 P Red	2 S White	1 P Blue	1 S Red
Sept. 3, Sept. 15	2 P White	2 S Blue	1 P Red	1 S White	2 P Blue	2 S Red	1 P White
Sept. 4, Sept. 16	1 S Blue	2 P Red	2 S White	1 P Blue	1 S Red	2 P White	2 S Blue

Watch Duties in Harbour

Out of working hours, both by day and by night, the "watch on board", and more particularly its duty part, must be ready at all times to turn to for any work or to deal with any emergency which may arise. In addition, the duty part provides the special parties detailed hereunder for certain routine or special duties. Some of these special parties may be required to sling in special billets where they can be called quickly in an emergency. The hands for each party are detailed either by the petty officer in charge of the duty part of the watch, or in daily orders.

DUTY HANDS

These consist of two hands from each part-of-ship, and two marines, with a leading seaman in charge. They are usually employed for all work out of working hours for which only a small party is required. If a similar party is required during working hours it is usual, in order not to interfere with the general work of the ship, to pipe "Two hands from each part-of-ship and two marines, and a leading hand from the (requisite) part" to muster; these men being immediately detailed by their respective Captains of Tops.

FIRE PARTY

This party consists of men detailed from all branches who are competent to deal with an outbreak of fire. It is under the charge of a petty officer, and usually includes the duty hands, a gunnery instructor, a stoker petty officer and stokers, an N.C.O. and marines, an engine-room artificer, electricians, a shipwright, a sick berth attendant, a supply assistant and a bugler.

DAMAGE CONTROL PARTY

This party is similar in composition to the fire party and is responsible for the routine closing of water-tight openings the last thing at night and for their opening as required first thing in the morning. They also go the rounds between decks during silent hours to ensure that the water-tight integrity of the ship is maintained.

NIGHT BOAT'S CREW AND LOWERERS

Out of working hours, day and night, a boat is kept ready for immediate use in the event of any emergency. A leading seaman is in charge, and the number of the crew detailed depends upon the size and type of boat detailed for this duty. Four lowerers, two to each fall, are also detailed should the boat be hoisted at davits.

ANCHOR WATCH

In heavy weather, or when the ship is anchored in an exposed roadstead or in a strong tideway, an anchor watch is "set", *i.e.*, detailed, to watch the cable, veer or heave it in, let go a second anchor, slip the cable, or weigh anchor, as may be necessary. An anchor watch usually includes two or more seamen, a stoker petty officer, a shipwright, an electrician and a signalman, all under the charge of a seaman petty officer; a quartermaster and telegraphmen are also detailed if steam is on the main engines. The anchor watch is backed up by the "cable party" of the watch or part, as necessary.

NIGHT SEARCHLIGHT'S CREW

One searchlight with its crew should be ready for immediate action during the night watches.

HAMMOCK STOWERS

These are detailed, from seamen, stokers and marines, to stand by the hammock stowages when the hands are called, and when hammocks are slung in the evening.

EMERGENCY PARTY

In some ships all or most of the preceding special parties may be combined in one single party known as the "emergency party", for dealing in its initial stages with any emergency which may arise.

Watch Duties at Sea

At sea it is usual for all hands to be "on deck", *i.e.*, available for duty and to work the normal daily routine from the time of "Hands fall in" to the end of working hours, and men are detailed from the watch on deck or duty part for specific watchkeeping duties and tricks.

After working hours, the first dog watchmen (or the afternoon watchmen on make and mend days) take over the watch on deck, and the watch system in force is then continued until the time of "Hands fall in" on the following morning.

The watch or part of the watch on deck is not usually allowed below decks, but may shelter on the weather decks.

Men are detailed from the watch or part of the watch on deck by the petty officer in charge for the special duties described below.

SOUNDING PARTY

This consists of a leading seaman and two or three hands who take soundings with the sounding machine as and when required.

SEABOAT'S CREW AND LOWERERS

Their number varies with the type and size of seaboat in use. They are detailed for the period of the watch and usually work only in the vicinity of the seaboats. The coxswain is a petty officer or leading seaman, and the lowerers (two or three to each fall) are under the charge of a petty officer or leading seaman.

LOOKOUTS

The number of lookouts depends upon the weather and other circumstances at the time. In peace, one look-out only may be closed up during daylight hours and two at night; but in fog or bad visibility, four or five may be closed up, one on each wing of the bridge, one in the eyes of the ship, one right aft, and one at the masthead. In war the number of lookouts is considerably increased, and they are detailed in accordance with the armament organisation of the ship. Lookouts work in tricks, usually of one hour's duration, but this may be reduced to 20 minutes in war. Their duties are laid down in B.R. 797, *Handbook of Lookouts*.

HELMSMAN AND TELEGRAPHMAN

A helmsman is detailed to steer the ship for a trick usually of one or two hours duration, and a telegraphman is detailed to work the engine-room telegraphs for the duration of the watch. Both work under the supervision of the quartermaster.

LEADSMEN

A leadsmen is detailed only when required; he mans the chains and takes soundings with the hand leadline under the supervision of a quartermaster or a boatswain's mate.

SEARCHLIGHT'S CREW

This crew is detailed for the duration of the watch during the dark hours.

SHIPWRIGHT OF THE WATCH

The duties of the Shipwright of the Watch include going the rounds of the ship at intervals to see that hatches and scuttles are properly closed and that the ship is not taking in water anywhere.

SEAMAN GUNNER OF THE WATCH

The seaman gunner detailed for this duty provides pyrotechnics (*i.e.* fireworks), and the line throwing gear and any other similar equipment, as required.

BRIDGE MESSENGER

A seaman or a boy, is detailed for the duration of the watch and works under the orders of the Officer of the Watch.

Evolutions

In addition to her normal tasks, a ship must be prepared to deal immediately and efficiently with any emergency or eventuality which may come her way. It would not be possible to issue detailed orders to meet every situation which might arise, but it is possible to issue such orders for certain duties or emergencies which it is known from past experience are likely to be encountered, and these are known generally as "evolutions".

Each evolution requires a certain number of men for its efficient execution in the shortest possible time; if too many men are detailed they will hamper each other's work, and if too few the evolution will take longer to complete, or may even be impossible to execute. It is therefore usual to make out stations for evolutions on the watch system, employing a sub-division, a part of watch, a watch, or all watches, according to the nature of the evolution, and to apportion the provision and working of the necessary gear among the parts-of-ship in the watch or part of the watch concerned.

Detailed orders for evolutions are issued as a "station bill"; this bill is quite separate from the *Watch and Station Bill*, which is chiefly concerned with quarters. The principal evolutions included in a station bill are shown in the table below.

STATION BILL

FOR ALL HANDS	FOR THE WATCH OR WATCHES	FOR A PART OF A WATCH
Damage control	Damage control	Damage control
Landing parties	Prepare for sea	Darken and undarken ship
Muster by open list	Store and provision ship	Out and in paravanes
Payment	Ammunition ship	Replenishment at sea
Divisions and quarters	Replenishment at sea	Out kedje anchor
Entering or leaving harbour	Prepare for towing	Dress ship
Muster for drill	Out bower or stream anchors	Rig church or cinema
Man ship	Paint ship	
Air bedding		

DAMAGE CONTROL

These stations include stations for fire, flooding, collision or structural damage, and the routine for closing and opening all water-tight fittings. The organisation for damage control is described in Chapter XIV.

LANDING PARTIES

These parties consist mainly of seamen, stokers, electrical ratings and marines, with a small proportion of officers and men from other branches. They are organised in platoons and companies, which together with those from other ships may be formed into battalions. Each ship carries a sufficient number of small arms and minor weapons to arm its landing party for active service ashore, or to act in aid of a civil power to maintain order.

MUSTER BY OPEN LIST

This muster, in which the whole ship's company is assembled in the order in which their names appear in the ship's ledgers, is carried out once a quarter. Each man steps before the Captain and states his rate, his name, and the sources from which his pay and allowances are computed; *e.g.*, "Able Seaman Brown, Sir, layer rating third class, one badge, married, one child". The object of this muster is to check the details in the ship's ledger of each man's pay and allowances.

PAYMENT

The ship's company is paid, usually once a fortnight, by the Supply Officer and his staff from pay tables which are set up in some convenient place in the ship. At each pay table a witnessing officer is detailed to witness the payment at that table and to investigate any queries. Before payment the ship's company is mustered in groups according to the ship's book number and pay list of each man. The usual pay lists into which a ship's company is divided are: 5—seamen; 5A—engine-room ratings; 5B—artisans; 5C—sick-berth ratings; 5D—supply ratings; 5E—miscellaneous ratings; 9—band; 11—Royal Marines. Each of the lists is divided into two parts, Part I for chief and petty officers, and Part II for other rates.

DIVISIONS AND EVENING QUARTERS

These musters may be held either daily, or occasionally, as ordered by the Captain. The chief purposes of "divisions" are:—

- to muster the ship's company;
- to ensure that each man is correctly dressed, and to foster generally smartness of appearance and good bearing;
- to enable the men to see their divisional officers, and the officers their men.

The purpose of "evening quarters" is to muster the ship's company when work is finished and to allow of the mess decks, flats, and other spaces between decks being inspected to ensure that they have been cleared up and left shipshape. At evening quarters the duty part of the watch may be ordered to carry out one of the minor evolutions.

At both these musters the ship's company is fallen in by divisions, each in its allocated position on the weather decks.

ENTERING OR LEAVING HARBOUR

When a ship enters or leaves a harbour the ship's company is fallen in by divisions on the weather decks. On these occasions the ship and her company are critically watched, not only by other warships, but by merchantmen, longshoremen, and civilians. The ship should therefore look as smart as possible, and particular care should be taken that every one is correctly dressed in the "rig of the day", that scuttles and weather doors are closed and no one looking out of them, and that everything is ship-shape.

MUSTER FOR DRILL

In harbour, one day a week is usually set aside for "general drill", when the ships present compete with each other in carrying out various evolutions ordered by signal from the Senior Officer. Gear required for the drills likely to be ordered is placed beforehand, and, at the time the drills are due to begin, the order "Fall in for general drill" is usually piped, the ship's company being mustered on the weather decks, either by divisions, parts-of-ship, or watches.

MAN SHIP

Manning ship is a ceremonial mark of respect carried out on special occasions, as described in Volume I of this manual. The ship's company is stationed at close intervals along the weather decks and superstructures, about one pace clear of the guardrails, thus forming an unbroken line of men on each side throughout the length of the ship.

AIR BEDDING

Weather permitting, the bedding of all the ship's company is usually aired once a week. Hammocks are got up, unlashed, and then either hung with their bedding over the guardrails or triced up to the hammock gantlines on which each division has its allotted place. Care must be taken to stop each set of bedding securely and close to the next set, so that no "holidays" (gaps) are apparent from outboard.

PREPARE FOR SEA

Before a ship leaves harbour she is prepared for sea. This preparation includes: equipping and rigging the seaboats; testing the main engines, steering gear, syrens, sea communications and compasses; singling up the berthing hawsers if alongside; reeving the slip-rope and preparing to unshackle the bridle of the cable if at a buoy, shortening in the cable if at single anchor, and unmooring if moored; setting up the guardrails; covering and securing all movable gear; covering and securing boats; closing certain doors, hatches and water-tight openings. The Executive Officer, Engineer Officer and Electrical Officer each report to the Captain, before the ship is due to leave her berth, that his department is ready for sea.

STORE SHIP

Careful preparation beforehand is necessary for storing a ship quickly and efficiently, and this operation is usually carried out at from three to six-monthly intervals. The chief requirement is to ensure a free flow of the stores from the jetty, store ship, or lighters, to dumps on the weather decks and thence to the store and provision rooms.

The preparations include rigging the necessary derricks, siting the dumps, providing barrows, opening the necessary doors and hatches, rigging whips and tackles and organising traffic routes.

AMMUNITION SHIP

Embarking or disembarking ammunition is an important operation which usually involves the whole of the complement of Seamen and Royal Marines. It requires careful planning and organisation, and, in view of the dangerous nature of the work, certain precautions must be observed while this work is in progress. Detailed regulations for ammunitioning are laid down in several handbooks, but the more important are summarised below.

- (i) Only the whips, tackles, grabs and other equipment specially provided for the purpose may be used.
- (ii) All gear must be tested before and after use, and it must be closely watched while in use.
- (iii) No smoking is to take place while ammunition is being embarked or disembarked.
- (iv) No wireless transmission is allowed while ammunitioning is in progress.
- (v) Normally, ammunitioning is stopped during wet weather or thunder storms.
- (vi) Petrol and paraffin may not be embarked or disembarked at the same time as ammunition.

REPLENISHMENT AT SEA

A ship must be prepared to embark or disembark men, fuel, stores and ammunition while at sea from or to ships of the Fleet Train. Some of these evolutions are described in Chapter XII.

PREPARE FOR TOWING

When at sea a ship should always be prepared to tow or be taken in tow at short notice. Either evolution may have to be carried out from either end of the ship, and stations must be organised accordingly. Preparations for towing are described in Chapter X.

OUT BOWER, STREAM OR KEDGE ANCHORS

These evolutions are normally exercised in harbour, but may actually have to be carried out in exposed shoal waters. The chief purposes of laying out an anchor are :—

- (i) to provide a means of hauling the ship out from her berth if there is lack of manœuvring space ;
- (ii) to keep the ship pointed in a certain direction, or to keep her from swinging to wind or tide when at anchor ;
- (iii) to haul the ship off a shoal, or clear of some navigational danger.

These evolutions are described in Chapter X.

PAINT SHIP

Stations for painting ship overall must be carefully organised to ensure that the work is carried out thoroughly and quickly. Details include the preparation of sufficient quantities of paint, the provision of an adequate number of brushes and paint pots and arrangements for replenishing the latter, and the rigging of painting stages.

DARKEN AND UNDARKEN SHIP

In war and during fleet exercises a ship is darkened at dusk and undarkened at dawn, as ordered by the Captain or the Officer of the Watch. Stations for darkening ship must be organised in detail to ensure that no scuttle or aperture is missed through which artificial light can be seen from outboard.

OUT AND IN PARAVANES

Paravanes are used to protect a ship from moored mines and are therefore streamed in shallow water where such mines might exist. A description of paravanes, and of how they are got in and out, is given in Chapter XI.

DRESS SHIP

Ships are dressed overall on certain anniversaries of national importance when in harbour. The method of dressing ship is described in Chapter XVII.

RIG CHURCH OR CINEMA

Owing to lack of space in a ship the seating accommodation and special equipment for divine service and for cinema shows have to be rigged and unrigged on every occasion of holding them. Special stations are detailed for these purposes.

Petty Officers' Routine Duties

Petty officers are detailed in turn to carry out the routine duties described below for a period of 24 hours at a time.

The Duty Petty Officer is detailed from all the petty officers of the seamen, stoker and artisan branches; senior N.C.O.'s of the Royal Marine detachment are also detailed for this duty. His duties include attending all the main issues of spirit, meat and provisions to check that they conform to the regulations regarding their quality and quantity, and to report any queries or complaints to the Officer of the Watch.

The Duty Disciplinary Petty Officer is detailed from the seaman petty officers. His duties include calling the hands in the morning and mustering men under punishment at the times laid down; he also takes charge of the men under punishment during extra work or drill.

The Duty Regulating Petty Officer is also detailed from the seaman petty officers. He calls the hands in the morning, musters and checks libtymen, goes the rounds between decks after the return of the last liberty boat, closes officers' messes at the regulation hours, takes offenders after working hours before the Officer of the Watch, is responsible to the Master-at-Arms for any cell offenders, reports evening rounds in the absence of the Master-at-Arms, and assists generally in regulating duties.

The Duty Mess Deck Petty Officer, who is also detailed from the seaman petty officers, supervises the mess decks, flats, bathrooms and drying rooms after working hours, and sees that they are cleared up at the regulation times.

The Duty Gunnery Instructor is detailed from the gunnery instructors. He goes the rounds in compartments adjacent to magazines once in each watch, except between the hours of 2000 and 0800 when these rounds are carried out by an officer. He is responsible to the Officer of the Watch for the covering and uncovering, and security generally, of the ship's gun armament. In ships with small petty officer complements he may also be detailed to take his turn as Duty Disciplinary Petty Officer.

The Duty Boys' Instructor is, out of working hours, in general charge of the boys, and he sees that their mess deck is cleared up and that they turn in at the regulation time. If insufficient boys' instructors are borne these duties may be taken over by one of the other duty petty officers.

Petty Officer's Special Duties

The special duties of a standing nature for which petty officers are usually detailed are listed and described below.

The Chief Boatswain's Mate. A chief or senior petty officer of the seaman branch is allocated to this duty. He assists the Boatswain in taking general charge of, and maintaining, the upper deck stores, gear and rigging. Where no Boatswain is borne he carries out that officer's duties. He takes charge of all main musters of the hands and watches except clear lower deck, divisions and evening quarters, and reports them to the Executive Officer or his deputy. He personally assists the Executive Officer and the Boatswain in the general working of the ship and at drills and evolutions.

Captains of Tops. A chief or senior petty officer of the seaman branch is allocated from each watch, to take charge of each part-of-ship. They are known as the First and Second (or First, Second and Third) Captains of Tops. At main musters they report their part-of-ship to the Chief Boatswain's Mate. In the absence of the latter the senior captain of a top present takes charge of the muster.

The Messdeck Petty Officer. A chief or senior petty officer of the seaman branch is placed in general charge of the mess decks. He is responsible to the Mess Deck Officer for the cleanliness and upkeep of the living spaces below decks.

The Captain of the Side. A seaman petty officer is detailed to take charge of the Side Party, which is made up of seamen from each part-of-ship. He is responsible for the cleaning and touching up of the ship's side, and the painting of the cable between the hawse pipe and waterline; he is also responsible for the disposal of "gash" and the working of the incinerator.

Boys' Instructors. One boys' instructor for every 20 boys is usually allowed by complement and they are detailed from the seaman petty officers. They are in general charge of the boys, and are responsible to the officers of the Boys' Division for their discipline and instruction.

Physical and Recreational Training Instructors are specially qualified chief petty officers, petty officers, or leading seamen, whose duty is to instruct the ship's company in physical and recreational training. They are in charge of the sports gear, assist the Sports Officer in arranging all sports and recreation, and assist the Welfare Officer in his duties. They may also be detailed to carry out the duties of a boys' instructor and to assist with instruction in seamanship.

The Admiral's and Captain's Coxswains are both chief or petty officers detailed, respectively, as coxswains of the barge and galley. They attend, respectively, on the Admiral and Captain when the ship is entering or leaving harbour and on other occasions at sea as required. In harbour they take charge of the work of their boats' crews, as directed by the Flag Lieutenant and Captain.

Special Dutymen and Special Parties

There are many special duties of a standing nature in a warship for which men are detailed, either individually or in special parties. Men so detailed are known as "special dutymen" and work to a special routine. Special dutymen are excused many of the routine musters and general ship work, but carry out their watch duties with the remainder of their watch or part of a watch.

They are usually relieved about every three months to enable them to gain the necessary experience of part-of-ship work.

The usual special duty-men and special parties detailed in a big ship are listed below, together with an explanation of their duties.

Side Party. See under "Captain of the Side", page 75.

Gunner's Party. A party of seamen and marines, including the "Gunner's Yeoman", who are detailed from the parts-of-ship and work under the Gunner to keep those magazines, shell rooms, store rooms, stores and spare parts for which the Gunner is responsible in a clean and efficient condition.

Armament Sweepers. A similar party, also detailed from the parts-of-ship, who work under the departmental officers responsible for the cleaning and maintenance of the ship's armament and its associated equipment.

Boatswain's Party. A small party of seamen, including the "Boatswain's Yeoman" and usually under the charge of a petty officer or leading seaman, who work under the Boatswain or Chief Boatswain's Mate to keep clean and in good order the boatswain's stores, and canvas and rope gear which are not under the charge of the captains of tops. They also carry out all repairs to the standing and running rigging which are beyond the capacity of the parts-of-ship.

Supply Party. This consists of seaman, stokers and marines, and is usually under the charge of a petty officer or leading seaman known as the "Captain of the Hold", who works under the orders of the Supply Officer. They keep the store rooms clean and in good order, assist in the maintenance of all naval stores, get up victuals and provisions, and in some ships they may assist the galley staff to prepare, cook and serve the ship's company's meals.

Ship's Butcher. This duty is carried out by a specially qualified seaman or marine who works under the orders of the Supply Officer.

Laundry Party. The ship's laundry is worked by this party, which consists of seamen, stokers and marines, under the charge of a petty officer or leading seaman.

Shipwright's Party. This party consists of seamen who work as mates to the shipwrights.

Heads Party. The ship's company's heads are kept clean and in good order by this party, which consists of seamen, stokers and marines, under the charge of a senior seaman rating known as the "Captain of the Heads".

Messmen. Seamen or stokers are detailed as messmen to each chief petty officers' and petty officers' messes. They are responsible for keeping their respective mess clean and for fetching and serving the meals and dishing up afterwards.

Sweepers. Seamen, stokers and marines are detailed as "sweepers" for the cleaning and upkeep of each mess deck, flat, bathroom, drying room and other spaces or compartments between decks. They work with their part-of-ship when not required for these duties.

Cooks of Messes. The members of each broadside mess are detailed daily by its senior hand to take their turn as "cook of the mess". Their duties are to fetch, serve and dish up the meals, and to keep their messes clean and in good order. In harbour they are detailed from the watch on board.

Messengers. These special dutymen are detailed from the ordinary seamen and boys. They may work to a daily routine or by watches, and are allocated to the Captain, Commander, Officer-of-the-Watch, and other officers, and to the executive and armament offices, signal distributing office, ship's office, captain's office and other offices. Office messengers clean out their offices when the hands turn to in the morning.

Other special dutymen include the barge's or galley's crews, cabin hands, sailmaker's mate, and telephone exchange watchkeepers.

Excused List. If these special dutymen and special parties were excused all general ship's duties there would be insufficient hands available to work the ship. They are therefore listed in the ship's "excused list", which is prominently displayed and shows exactly which general musters and ship's duties each is excused, and which they are to attend to take part in.

Special Dutymen and Special Parties required for Occasional Duty

In addition to the foregoing there are a number of other special dutymen and special parties who are only required for duty occasionally. The more important of these are enumerated and described below.

Special Sea Dutymen. This is a standing party of petty officers and men of various branches who are detailed to man the navigating control positions when the ship is entering or leaving harbour. When the ship is clear of the harbour they are relieved by the sea dutymen of the watch on deck. The special sea dutymen in a big ship, together with their stations, are listed below.

The Chief Quartermaster	...	...	...	at the wheel.
The quartermaster of the watch, and telegraphmen	...	...	...	in the forward steering position.
The quartermaster longest off watch	...	...	...	at the after steering position.
Two boatswain's mates and two leadsmen	...	...	...	in the chains.
Two speed flagmen	...	...	...	on the bridge.
Two screw flagmen	...	...	...	on the after superstructure.
Two signalmen to watch screw flags	...	...	...	on the bridge.
The boatswain's mate of the watch	...	...	...	at the forward broadcaster.
Three telephone operators	...	...	...	one each on the forecastle, quarter deck and bridge.
The Captain's Coxswain, and the Captain's messenger	...	...	...	on the bridge.
The bridge messenger	...	...	...	on the bridge.
The bugler of the watch	...	...	...	at the forward broadcaster.

The Cable Party.—A standing cable party is usually detailed from each watch, with one of the captains of the forecastle in charge of each. They work the cables when the ship comes to an anchor, weighs, moors, unmoors, or makes fast to or slips from a buoy.

In addition to the necessary number of seamen, a shipwright, a stoker petty officer or an electrical artificer, a blacksmith, an electrician and a signalman are included in the party.

Patrols.—In many ports it may be necessary to land a patrol for the maintenance of good order and naval discipline among the libertymen ashore, and

to assist their safe disembarkation and embarkation from and into the ship's boats. The patrol is provided by seamen and stokers of the watch on board and is under the charge of a petty officer. They wear gaiters, belts and arm-bands, and are empowered to arrest any naval rating.

Watchkeepers

In harbour, most of the ship's company work to the daily routine of their respective departments, and the duty watch or part is used for any work required from after working hours to the time of "Hands fall in" the following morning. There are, however, many duties such as those of quartermasters, which require a continuous watch day and night. The men who carry out these duties are known as "watchkeepers", and they work to special routines for work, recreation, liberty and leave. Watchkeepers usually work in four watches, are allowed to lie in until "Up guard and steerage hammocks" is piped and are granted liberty out of the normal routine times. It is laid down in the *King's Regulations and Admiralty Instructions* that all watchkeepers must return on board at least four hours before they are due to go on watch.

In harbour the Seamen branch provide watchkeepers for the special duties described below.

Gangway Staff.—This comprises the quartermaster, boatswain's mate and the corporal of the watch. They usually work in four watches. The gangway staff is under the supervision of the quartermaster and is responsible to the Officer of the Watch or Officer of the Day for running the routine, guarding the main gangways, and keeping watch on the general safety of the ship and her boats.

Duty Boats' Crews.—Boats which are required to run day and night are provided with two crews, one from each watch. These crews work 24 hours on and 24 hours off duty, and usually relieve each other at 1230. The stand-off crew work with their parts-of-ship in the forenoon, and both crews join up with their parts-of-ship on going to sea.

The Guard.—In ships which carry Royal Marines the "guard" is provided from the R.M. detachment, otherwise it is provided by the seamen and stokers. The guard is under the charge of a petty officer or senior N.C.O. and provides the guards required for Colours and for the reception of senior officers. In addition, the guard provides sentries for such posts as the Admiral's or Captain's cabin, magazine keyboard and pistol rack, cells, forecastle and jetty.

Berthing

In general there are two systems of messing in the Royal Navy, known respectively as "Broadside" and "Cafeteria" messing. In the former system the men eat their meals in their messes, the meals having been prepared and cooked in the galleys and fetched by the cooks of messes. In the cafeteria system the men eat their meals in a common dining hall in the vicinity of the galleys and serveries, a separate dining room being reserved for chief and petty officers.

In either system the ship's company is berthed in separate messes distributed throughout the mess decks. Chief and petty officers are allotted "enclosed messes", which are screened by bulkheads or curtains from the remainder. The remainder of the ship's company are allotted "broadside

messes", which are not screened from each other and which occupy the remainder of the mess decks. As far as possible men are allocated to messes in the vicinity of their own part-of-ship or action station.

Each broadside mess is made up of an equal number of men from each watch and part of a watch, and cooks of messes are detailed from the watch on board.

Where the internal economy of the ship allows, it is the custom for the following categories of ratings to have separate messes, but this may be modified to suit different circumstances :—

- the Master-at-Arms ;
- chief petty officers (except those mentioned below) ;
- petty officers (except those mentioned below) ;
- all engine-room artificers ;
- mechanicians and chief stokers ;
- stoker petty officers ;
- regulating petty officers ;
- electrical and ordnance artificers (where space permits) ;
- senior Royal Marine non-commissioned officers and Bandmaster ;
- all officers cooks and stewards ;
- leading seamen and seamen, usually divided according to their parts-of-ship ;
- communications ratings of leading rate and below ;
- supply ratings of leading rate and below ;
- seamen watchkeepers such as gangway staff, telephone exchange operators and boat's crews ;
- leading rates and below of the electrical branch ;
- leading stokers and stokers ;
- boys ;
- Royal Marines.

As far as possible slinging billets are arranged so that each man sleeps in the vicinity of his mess, his action station, or the location of his usual work ; his kit locker and hammock stowage are also allocated on the same principle. Stowage for *attache* cases is provided on the mess decks, but kit bags and suitcases are usually stowed in baggage stores to avoid overcrowding the already very limited space on the mess decks.

Offices

The general organisation and administration of a warship is directed through several offices, the more important of which are briefly described below.

The Captain's Office deals with questions of general policy in the administration of the ship, with the records and documents relating to all her officers and men, and with all secret or confidential matters. All official mail is delivered to this office.

The Commander's Office administers the internal organisation of the ship and is responsible for the issue of routines, daily orders and similar matters.

The Gunnery Office deals with everything relating to the use, maintenance and repair of the ship's gun armament, the allocation of quarters, and the maintenance of the *Watch and Station Bill*, and with training the crew in handling the gun armament.

The Regulating Office is concerned with the discipline, liberty and leave of the ship's company, and with the "checking" of officers and men in and out of the ship.

The Pay Office, in which are kept the ship's ledgers, deals with the pay and allowances of the officers and men.

The Victualling Office administers the victualling of officers and men, the stowage and issue of provisions and clothing, and the preparation, cooking and serving of meals.

The Naval Store Office is concerned with the stowage, issue and return of naval stores, except the Boatswain's, Gunner's and other departmental stores.

The Engineer's Office organises and administers the engine room department.

The Electrical Office organises and controls the maintenance of all the ship's electrical equipment.

The Main Signal Office organises and controls the despatch, receipt, routing and internal distribution of all communications other than mail.

The Mail Office handles the despatch, receipt, collection and internal distribution of all Post Office mail, both official and private.

Daily Orders

Particulars of the work and duties of the ship's company, especially of those for the seamen branch, are published and issued by the Executive Officer's (i.e. Commander's or First Lieutenant's) Office as "Daily Orders", usually the evening before they are to be carried out. These orders include the names of those officers and men detailed to carry out routine duties, and also any orders or instructions required for duties of a non-routine nature. They are posted on the mess deck and other notice boards, and it is the duty of every individual in the ship to read them. Lack of knowledge of such orders is not accepted as an excuse for any failure to carry them out.

MESSING

General Messing

The larger modern warships are now (1951) messed on the "General Messing" system. Under this system the Supply Officer is allowed to spend up to an authorised daily money allowance for each member of the ship's company, plus a small additional allowance for each boy borne on the ship's books. Within the limits of these allowances the Supply Officer provides for the whole ship's company a daily menu which is designed to include a sufficient proportion of the various dietary needs such as meat, bread and flour, vegetables and fish. Adjustment of expenditure may be made from one day to another and the menus are varied as much as possible.

Considerable economy in expenditure is effected by this system, adequate meals are provided without additional mess bills being incurred by the men, and wastage of fat, bones and bread is almost eliminated and all the food purchased is used to the full.

Modified General Messing

Modern destroyers are now victualled on what is known as the "Modified General Messing" system. As the ship carries no Supply Officer she is treated

as a tender to a depot ship or base, whose Supply Officer is responsible for administering the messing, and it is in this respect that the General Messing system is modified.

A supply rating in the destroyer is detailed to keep a special provision account in which are recorded the quantities of all food-stuffs to be carried. Each month the Supply Officer of the parent ship or base sends a new provision account to the tender, together with menus for each day of the month and a scale showing the quantities of provisions to be issued. Some alternative menus are also provided so that, if obtainable, fresh provisions can be used instead of preserved provisions. In this system there is a daily *per capita* money allowance and a scale of allowances of rationed foodstuffs, neither of which should be exceeded.

The advantages of these General Messing systems are that :—

- (i) a complete dietary is provided without cost to the individual, whereas under the old "Standard Ration" and other victualling systems the cost of messing was often greater than the authorised allowance, so that the difference had to be met out of the man's own pocket ;
- (ii) the food is prepared and cooked in bulk by qualified cooks, whereas under the old systems the food was prepared separately in each mess by its own unofficial caterer, who usually had little or no culinary knowledge ;
- (iii) as the food is purchased in bulk large quantities can be stowed in store rooms and refrigerators, the menu can be more varied than under the old systems, and the cost is much less through buying at wholesale rates.

In both the General Messing and the Modified General Messing systems the food can be served under either of two systems, known as "Broadside Messing" and "Cafeteria Messing".

BROADSIDE MESSING

In this system the food for each mess is drawn from the galley in dishes by duty cooks of the mess and served out by them in their own mess. After each meal they also do the washing up.

CAFETERIA MESSING

In cafeteria messing the food is served on plates to each man and eaten in a common dining hall, the serving and washing-up being done by a special working party. This system is further subdivided into :—

- Self service*—in which the rating helps himself to a plate of food ; and
- Team service*—in which he sits at a table and the food is served to him.

Victualling Allowance

Small ships which are not fitted with modern electric galleys and not otherwise equipped for messing by the Modified General Messing systems are messed on what is known as "Victualling Allowance".

Under this system the food for officers' and mens' messes is drawn from the victualling stores, as required. The value of these issues, which are called issues on repayment, is charged at the end of each month against a monetary allowance known as Victualling Allowance, and any credit balance is used to pay any outstanding bills incurred by the messes for goods purchased during the month, from N.A.A.F.I., for example.

Cash Victualling

This system was introduced in 1940 for the benefit of small vessels when operating away from their parent ships or bases. The whole crew obtain a standard monthly cash advance from the Supply Officer of their parent ship or base, and are messes as one mess which obtains its supplies where and when it can by paying cash at the time of purchase. To prevent the crew being out of pocket through having to purchase their requirements from more expensive sources than those of the Service, the mess is reimbursed with the difference between the shore prices and the Service issuing prices.

PROVISIONS

Provisions is the general name used in the Royal Navy for all food and drink.

Provisions on Repayment

All provisions, except rum and lemonade, may be purchased by the messes on repayment at the prices published each half year in Admiralty Fleet Orders.

Routine for Issues

The routine for issuing provisions varies from ship to ship, but the following can be taken as typical :—

<i>Issue</i>	<i>Time</i>	<i>Place</i>
Frozen meat ...	0615 daily	... beef screen.
Bread and flour ...	1200 daily	... bakery.
Spirits ...	1200 daily	... recreation space.
Potatoes ...	1230 daily	... potato locker.
Repayment stores ...	1615 daily, except Sundays	... issue room.
Tea, sugar, milk ...	1230 Tuesdays	... issue room.
Soap and tobacco ...	once a month, in bulk	... store.
Clothing ...	1130 daily, except last week of month and last fortnight of quarter	... clothing store.

Extra Issues

Various extra issues are authorised in special circumstances ; examples are given below.

Lemonade and sugar	... in tropical climates and in hot weather, on the authority of the Medical Officer.
Oatmeal and sugar, lemonade and sugar	... to engine-room ratings.
Corned beef, bread, chocolate and sugar	... during severe exposure, for extra heavy work, etc.
Spirit (rum) ...	... on exceptional occasions.

Stocks Maintained

Stocks maintained on board should not be allowed to fall below those required for 30 days' average consumption, and maximum stocks embarked are

usually limited to those required for 90 days. This maximum may be increased at the discretion of the Senior Officer when stowage is available. In addition, 14 days' full sea rations should always be carried ; also a small stock of medical comforts, including pearl barley, Bovril and soups.

Methods of Packing

Provisions are supplied in packages of the following types.

In sacks or bags (weight 112-140 lb., according to article) : sugar, split peas, haricot beans, marrowfat peas, flour, rice and salt.

In cases (36, 48, 50 and 100 lb., according to article) : chocolate, tea, raisins and currants, corned beef, tinned salmon, mustard, pepper, jam, coffee, condensed milk, pickles and suet.

In cartons: many types of provisions are now (1951) packed in cartons.

In casks (10, 18, 27 and 36 gallon) : rum (chime painted red), vinegar (chime painted white), and sometimes oatmeal.

In cases, bales, wrappers and bags : clothing.

In cases and elm barrels : implements and mess traps.

Note : Rum and vinegar are designated " wet provisions ".

NAVAL STORES

The term " Naval Stores " describes all standard stores, except armament stores, which are issued for general use throughout the Royal Navy. Such stores are catalogued in a book known as the *Rate Book*, and they are on charge to the ship's Supply Officer, except in small ships with no Supply Officer where they are on charge to various departmental officers such as the Engineer Officer, Gunner and Boatswain.

Fuels, however, are always on charge to the Engineer Officer ; paint and timber are always on charge to the Shipwright Officer if one is borne, and if not they also are charged to the Engineer Officer.

Naval stores are classed as " permanent " or " consumable ".

Permanent Stores

The quantity of permanent stores of each kind carried in every type and class of ship is established on a certain scale and detailed in a book known as the *Establishment*. They are drawn, on temporary or permanent loan, as required by each department of the ship, and they are replaced if worn out or unserviceable. Unserviceable stores are surveyed in accordance with the regulations by ship's officers, who may condemn them as useless or repairable according to their condition ; all such stores are normally returned to dock-yard, but in certain circumstances some may be jettisoned.

Consumable Stores

The quantity of consumable stores carried also depends upon the type and class of ship and may vary from three to six months requirements, the requirements being calculated from previous experience. They are drawn by each department as required, but their supply is limited to a monetary valuation allowance authorised for the particular class of ship.

STOWAGE OF STORES AND PROVISIONS

Naval stores and provisions are stowed in "store rooms" and "provision rooms", each of which is designed to accommodate a particular type or class. These rooms are distinguished from each other by name and/or number, examples being : No. 1 Flour Room, Spirit Room, No. 2 Naval Store, Cool Room, Clothing (or "Slop") Room, Emergency Provision Room, Beef Screen, Potato Locker, and Issue Room. Some rooms, such as flour rooms, are provided with a ventilation system, and those not so provided can be ventilated when necessary by portable hoses from a nearby permanent ventilation system. Special stowages are provided for heavy items, and many rooms, particularly those for stores, are equipped with racks and battens.

In large ships the provision and store rooms of each type are duplicated or multiplied and widely separated, so that if, for example, one flour room is flooded or damaged in action, another will still be available. In the smaller ships there are usually two provision rooms, one forward and one aft, and an emergency provision room under the bridge, below the upper deck, to which easy access can be gained when at sea or in action.

The chief requirements for the efficient stowage of stores and provisions are that :—

- (i) every package should be securely stowed so that it will not shift in a seaway ;
- (ii) wherever possible, nothing should be in direct contact with the deck, bulkheads, ship's side or deckhead, in order to avoid damage from the moisture which frequently collects on these surfaces ;
- (iii) they should, where possible, be stowed so as to allow a free flow of air around them ;
- (iv) sufficient space should be left between them and the bulkheads, or ship's side, to allow access for repair or fire-fighting.
- (v) store and provision rooms should be adequately ventilated to prevent the air from becoming damp and depositing moisture ; this is particularly important in the stowage of canvas, cordage, flour and other substances similarly susceptible to damage by moisture ;
- (vi) store and provision rooms should always be kept clean and dry.

Stowage of Inflammable Liquids

Petrol and paraffin may only be stored in special tanks, or in special cans in racks on the upper deck where they can be readily jettisoned in an emergency. All other inflammable liquids may only be stowed in special rooms which can be rapidly flooded or sprayed in the event of fire ; these are the Inflammable Store, the Spirit Room, and the Paint Store. All casks containing inflammable liquids (except rum) are labelled with pink labels marked *Inflammable*.

All the precautionary measures to be observed in the stowage of stores are contained in the *Naval Storekeeping Manual*.

Other Special Stowage Requirements

Flour, sugar, peas and beans are all very susceptible to vapour, and so are easily flavoured by oil fuel or other noxious fumes ; for this reason no oil tank

below flour or other provision rooms should be opened until all such foods have been cleared, nor should such provisions be embarked or transported with paraffin or other similar liquids.

Potatoes, fresh vegetables, and fresh fruit must not be stowed between decks or in unventilated rooms, because potatoes develop poisonous gases, and fresh fruit and vegetables rapidly go bad unless they are continuously and freely ventilated. Fresh eggs are liable to be contaminated by smells and should therefore be stowed away from smelly articles and in a well ventilated place.

It is essential to put refrigerated provisions into the cold or cool rooms as quickly as possible. The slightest delay, particularly in warm weather, not only results in the outside starting to thaw, which, for example, results in black mould on beef, but seriously affects the refrigeration of the provisions already in the cold room or cool room.

Casks should be stowed in the racks provided, with their longitudinal axes fore-and-aft, bungs uppermost, and their bilges free (*i.e.* clear of the deck). If no racks are provided they should be bedded securely on dunnage (pieces of wood or other packing material) so that their bilges are free and their quarters supported. Each cask of a riding tier should rest with its bilge supported by the quarters of four casks of the tier below ; to avoid the casks of the bottom tier from being stove in by the weight of the casks above them the maximum numbers of the tiers allowed are : for barrels (36 galls.)—8 tiers ; for hogsheads (54 galls.)—6 tiers ; for punchions (72 galls.)—4 tiers ; and for pipes and butts (105/108 galls.)—3 tiers.

It is essential that the transport of provisions from the dumps to the provision rooms should be properly supervised to ensure careful handling, and to this end speed should be sacrificed if necessary. This is especially important with provisions in sacks or packages, and if a container is holed or split it should either be repaired or the contents be transferred to a new one before stowing.

Preparing for Provisioning

Arrangements should be made with the victualling yard for provisions which will be stowed in the same or adjacent store rooms to be sent in the same lighter. Boat-ropes and fenders should be got ready for the lighters coming alongside, derricks should be rigged and power be supplied to the motor hoists, and mats should be placed at each dump. Three provision nets should be provided at each hoist. Hatchways leading down to the store rooms should be cleared away and davits rigged if necessary ; any hatchway from which the ladder has been removed must be roped off. It is often quicker with many kinds of provisions to slide them down a chute of planks rigged on the hatchway ladder instead of unshipping the ladder and striking them down by davit ; shot mats should always be placed at the bottom of each chute to prevent damage to the cases. Similarly, where it is necessary to transport casks from one compartment to another, ramps should be fitted and placed over the door sills.

All provision rooms, empty or otherwise, should be cleaned and swept, and any provisions remaining in them should be restowed in such a way that they will be readily accessible for issuing before the new stock. Clean tarpaulins should be provided at each dump for protecting the provisions from contamination with the deck and keeping the deck clean, and for protecting any provisions stacked there from rain or a hot sun ; it is particularly important to keep flour

and other bagged provisions from getting wet, and to prevent frozen meat from thawing. Adequate arrangements should be made for identifying and mustering the provisions as they are embarked, and for supervising their transit from truck or lighter to the provision room in order to guard against pilfering, especially when any shore labour is employed ; all provisions and naval stores are on charge to the Supply Officer, and he and his staff are answerable for any losses by pilfering.

CHAPTER V

Rope and its Usage

SEIZINGS

Types of Seizings

A SEIZING may be defined as being a method of fastening together two parts of rope sufficiently strongly to stand a required strain. Three standard seizings designed to meet certain specific requirements are employed in the Royal Navy. Although, on occasion, departure from them in detail may be made, they should be regarded as the basis for all-round work of this description.

FLAT SEIZING

This is a light seizing for use when the strain on the two parts of rope is equal. It consists of one layer of approximately 11 round turns.

ROUND SEIZING

This is also used when the strains on the parts are equal, but it is stronger than a flat seizing. It consists of approximately 11 round turns and 10 riding turns; the number of riding turns is always one less than the number of round turns.

RACKING SEIZING

When the strains on the parts of the rope are unequal or exerted in opposite directions a racking seizing is used. It is formed by passing one layer of racking turns, and then passing one of round turns so that they lie between the racking turns. The number of round turns is necessarily one less than the number of racking turns. Sufficient turns are taken for the length of the seizing to be equal to the circumference of the rope (*i.e.* for racking two 3-inch ropes an overall length of seizing of 3 inches is required).

Strength of Seizings

For seizing cordage it is usual to use small stuff (2-lb. line, codline, or nettle-stuff, for example, depending upon the size of rope to be seized). When seizing wire ropes flexible mild steel wire is used.

The number of turns to be used for a seizing depends upon the strength of the seizing stuff and the strain to which the seizing will be subjected. For cordage, 11 and 21 turns have been recommended for flat and round seizings respectively, and a length of seizing equal to the circumference of the rope has been recommended for the racking seizing. These figures are based on a size of seizing stuff of about one-sixth of the size of the rope; *e.g.* codline, would be required for seizing a three-inch sisal rope.

Another method of assessing the number of turns for a racking seizing is to divide the breaking stress of the rope by one and a half times the breaking stress of the seizing stuff; 31 turns of codline would be required around two parts of of a four-inch sisal, for example.

Making-up Seizing Stuff

To make up left-hand twist spunyarn for a seizing or a service, wind it clockwise around the left hand with as many riding turns as are required, and finish with a clove hitch on the bight around the middle. Work with the first end which is drawn out through the opposite side of the coil, thus thorough-footing the spunyarn and making it easier to work with by taking the twist out of it. The turns in the coil are held in place by the clove hitch.

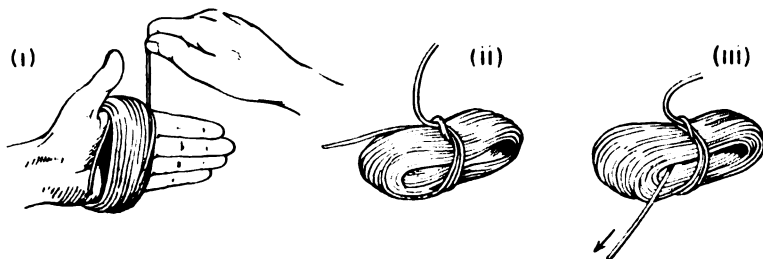


Fig. 61.—Making up seizing stuff

Use of Heaving Mallet and Spanish Windlass

When seizing heavy rope the turns must be hauled more than hand taut, and for this purpose the following mechanical aids may be used :—

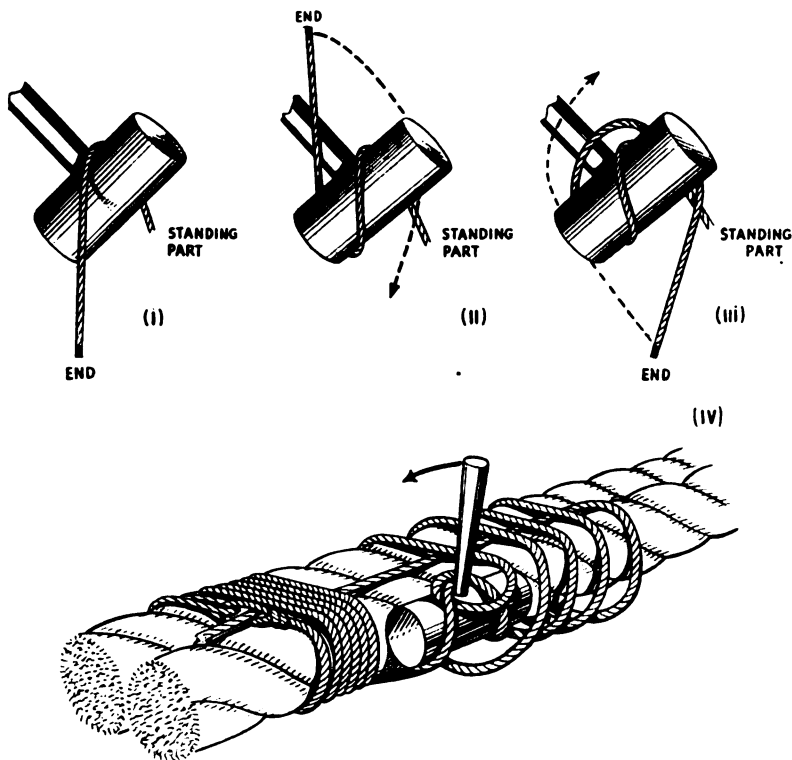


Fig. 62.—How to use a heaving mallet

- (a) *Heaving Mallet* (Fig. 62).—The lower turns of a seizing can be tautened with a heaving mallet as follows :—
- (i) lay the mallet in the bight of the line, as shown in Fig. 62(i), and as close up to the work as possible ;
 - (ii) take a turn diagonally round the head of the mallet, bringing the end up the opposite side of the handle (Fig. 62(ii)) ;
 - (iii) take half a turn round the handle, and take the end again behind the head (Fig. 62(iii)) ;
 - (iv) jam the end between the head and the standing part, and bring it up over the handle, as indicated by the dotted line in Fig. 62 (iii) ;
 - (v) place the head against the rope and heave, using the handle as a lever (Fig. 62 (iv)).
- (b) *Spanish Windlass* (Figs. 63 and 64).—This also can be used for tautening the lower turns of a seizing. The windlass is formed by taking a turn with the line to be tautened round a suitable bar, and then turning the bar with a lever inserted through a bight of this line, as shown in Fig. 63.

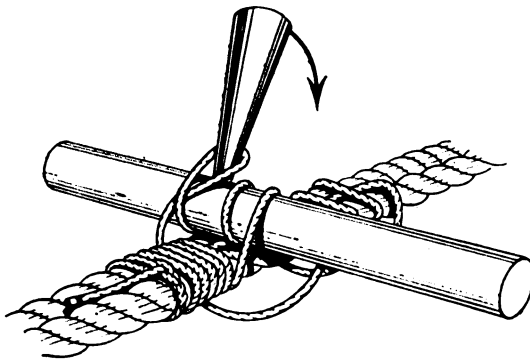


Fig. 63.—A Spanish windlass

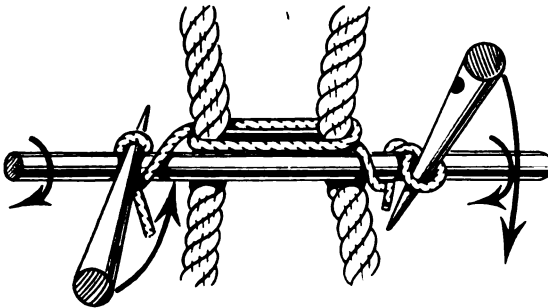


Fig. 64.—Racking two ropes with a Spanish windlass

A Spanish windlass can also be used to rack the two parts of rope together before putting on the seizing. For this purpose it is formed with a strand, well greased along its middle part, with a spike inserted at each end of the bar for use as levers, as shown in Fig. 64.

Passing Seizings

All seizings are begun by making a small eye in the end of the seizing stuff. Take the seizing round both parts and pass the end through the eye, taking care to keep this eye in the centre and clear of both parts of the rope (see Fig. 65 (i)).

To Pass a Flat Seizing (Fig. 65).—Having begun the seizing as described take the round turns very loosely round both parts of the rope, then pass the end back, along and between the two parts of the rope, under the turns and through the eye of the seizing, as in Fig. 65(ii).

Then heave each turn taut and take a cross turn round the seizing between the two parts of rope, as in Fig. 65 (iii).

Then haul the seizing well taut and secure its end with a clove hitch, one part of the clove hitch being on each side of the round turn, as in Fig. 65(iv). Finally, unlay the seizing stuff and finish off with a crown and wall close up against the hitch, as in Fig. 65(v).

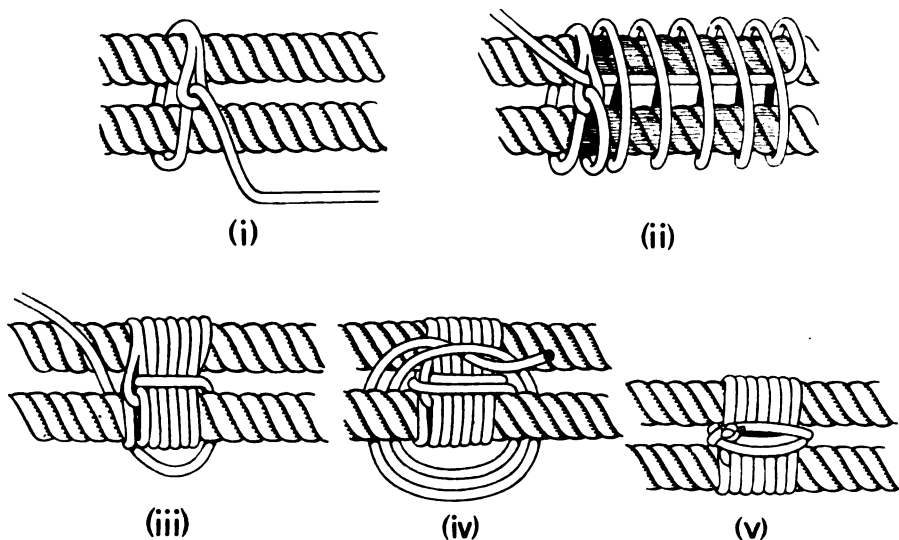


Fig. 65.—Passing a flat seizing

To Pass a Round Seizing (Fig. 66).—Having begun the seizing as previously described, take the same round turns as in the flat seizing, pass the end down between the parts, up through the eye, and heave each turn taut with a heaving mallet or Spanish windlass, as before (Fig. 66(i)). The end is now in the right position to begin passing the upper or riding turns, which will come exactly between the parts of the lower turns. There are one fewer riding turns than lower turns, and they are heve taut by hand.

After passing the last riding turn lead the end under the last turn of the lower turns and heave it hard taut (see Fig. 66(ii)), then take a cross turn round all parts of the seizing (see Fig. 66(iii)), heave it well taut, and secure with a clove hitch each side of the round turn, as in the flat seizing (Fig. 66 (iv)).

To finish off unlay the end of the seizing back to the clove hitch and make a crown and then a wall underneath it.

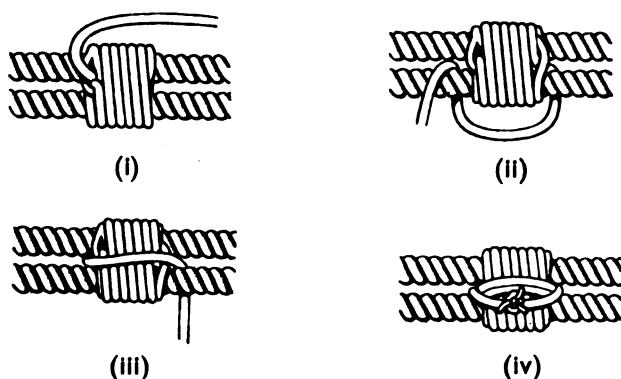


Fig. 66.—Passing a round seizing

To Pass a Racking Seizing (Fig. 67).—Begin the seizing as already described. If the seizing slips when taken round both parts of rope take the end round one part only and reeve it through the eye. Then dip the end between the two parts of rope and take a number of figure-of-eight turns round each part alternately, taking care to have the same number round each part and to leave room between each racking turn for the round turn which will come later (Fig. 67(i)). When the racking turns have been hove taut, dip the end under the last turn and pass the round turns back towards the eye, filling the spaces between the racking turns (Fig. 67(ii)).

When the last round turn has been passed (see that there is one less than the racking turns) finish off the seizing with one round turn around the whole seizing and a clove hitch between the two parts of rope; then unlay the end and form a crown and a wall under it, as in the round seizing (see Fig. 66(iv)).

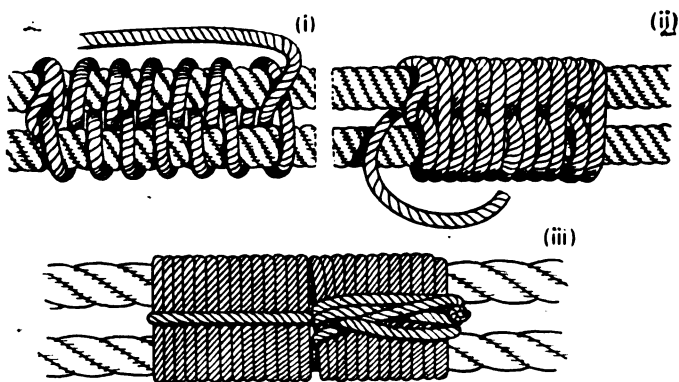


Fig. 67.—Passing a racking seizing

If the seizing has a large number of turns it is finished off by passing a round turn around one half of the turns, and a round turn and clove hitch around the other half (see Fig. 67(iii)), before making the crown and wall.

ADVANCED SPLICING OF CORDAGE

Long Splice

The principle of the long splice differs radically from that of the short splice. In the long splice one strand from each rope is unlaid, and one from the other rope is layed up in its place; the remaining strand from each rope remains in the centre, resulting in three pairs of strands spaced equidistantly along the married ropes. One third is now taken out of all strands, and though discarded these thirds should not be cut off until the splice is completed. Each pair of strands is then tied in an overhand knot, left over right, and each end is tucked over one strand and under the next, as for a short splice, with one tuck each side of the overhand knots. The splice is finished by stretching it and hauling taut all ends, including the " thirds ", and then cutting them off.

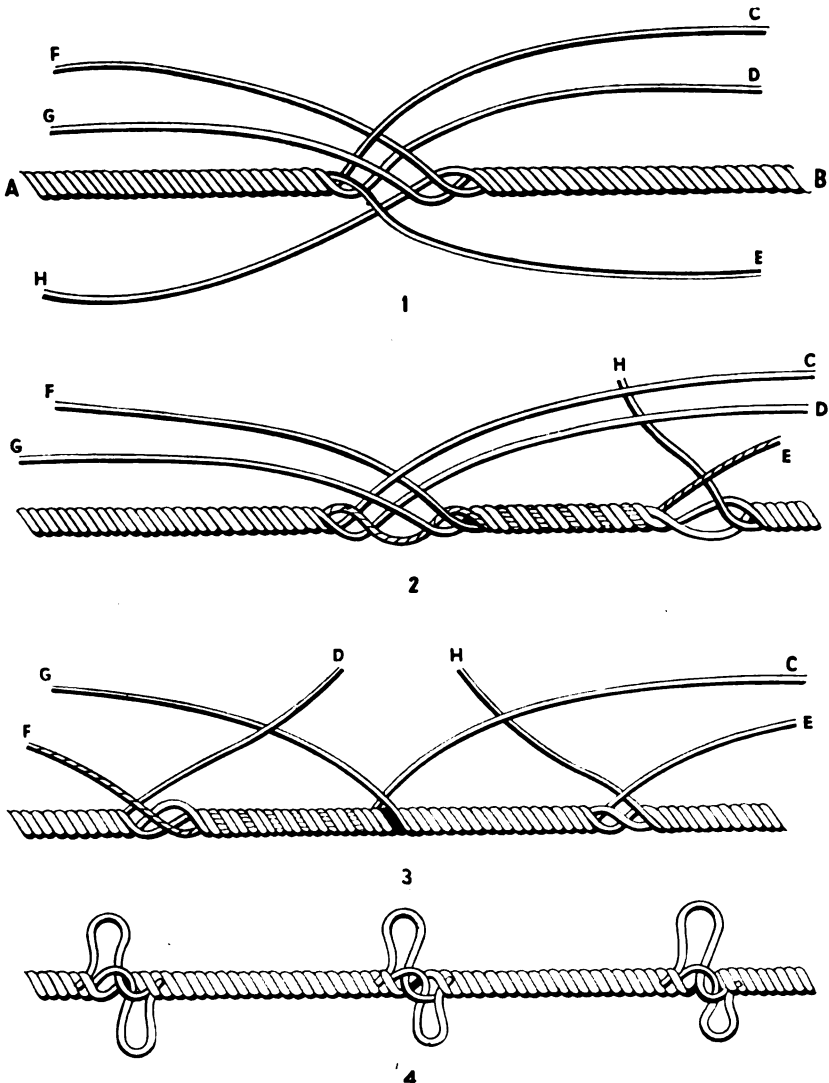


Fig. 68.—Making a long splice

To make a long splice whip each rope at a distance from its end equal to 12 times the size of the rope, then unlay the strands to the whipping and whip their ends.

Marry the two ropes together as in the short splice.

Each strand unlaied as described above is followed up by the strand from the other rope, which lies on its right in the marriage so that :—

D is unlaied and followed up by F,
H is unlaied and followed up by E,
and C and G remain at the marry.

Each strand is unlaied until the length of the end of the strand following it up is reduced to four times the size of the rope. In splicing a 2-inch rope therefore :—

D would be unlaied until 8 inches of F remained,
and H would be unlaied until 8 inches of E remained.

Cut Splice

Whip each rope at a distance from its end equal to five times the size of the rope, then unlay it to the whipping and whip the end of each strand.

Place the ends of the two ropes alongside and overlapping each other, and stop them together.

Tuck the unlaied strands of both ropes and finish them off as for an eye splice.

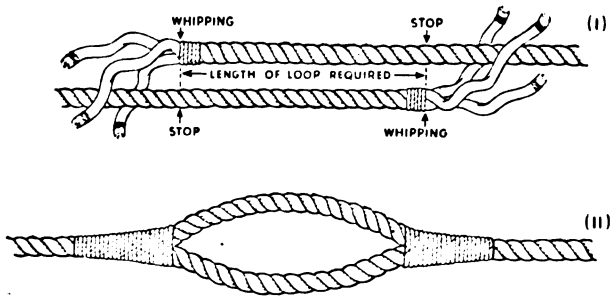


Fig. 69.—Making a cut-splice

Chain Splice

Unlay all three strands rather more than for an eye splice. Then unlay one strand, A, for another 6 inches, or twice the intended length of the eye (see Fig. 70(i)).

Now pass strands B and C through the link on the end of the chain and marry up with A, thus forming the eye (see Fig. 70(ii)).

Then further unlay strand A and lay up B in its place for about one foot, and then overhând knot and tuck these strands as for a long splice (see Fig. 70(iii)). Now tuck strand C into the standing part below the eye (as for a short splice) with about three tucks, so as to meet strand A. Then haul taut all ends and cut off.

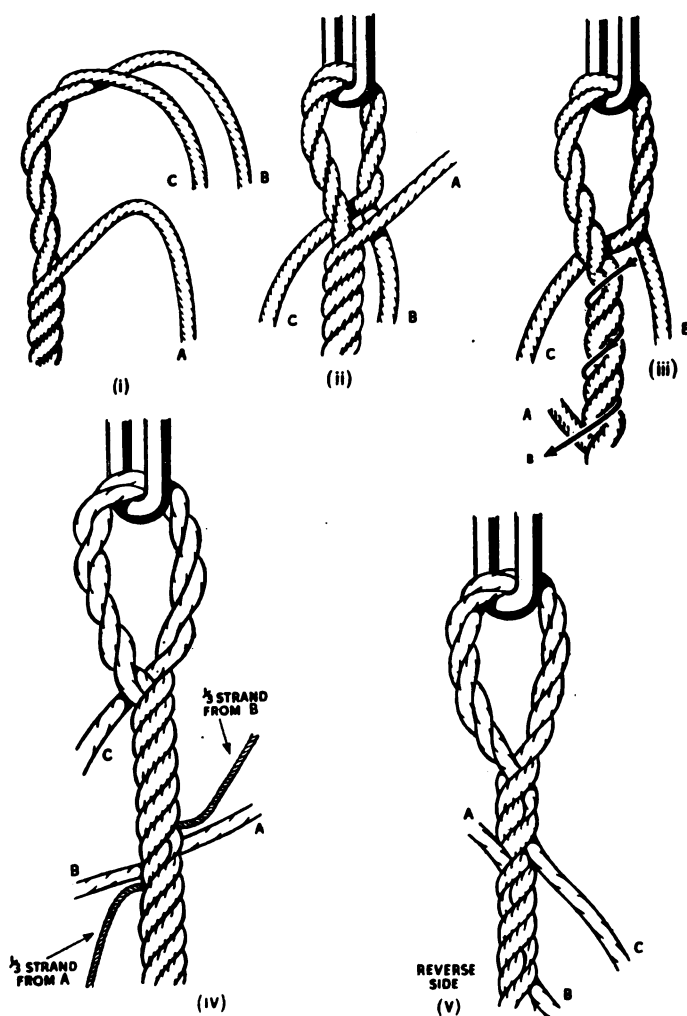


Fig. 70.—Making a chain splice

Flemish Eye

Whip the rope at a distance from its end equal to three times the intended circumference of the eye. Now unlay the strands and then the yarns, select the number of inside yarns necessary to make the eye the required size, and stop the remainder back on the rope.

Take a fid or circular billet of wood equal in diameter to that of the inside of the eye, and secure stops along it as shown in Fig. 71(i). Then divide the yarns selected for making the eye into half, one half each side of the fid, and overhand knot them in pairs over the fid; each pair should be so knotted at different parts of the fid, thus spacing the knots all round the eye.

Now free the stops on the fid and with them secure the eye temporarily in position. Then remove the fid, cut away the unwanted ends and marl down (Fig. 71(ii)).

Finish off by serving the whole eye, or, if extreme neatness is desired, graft it over completely. A sufficient number of the outer yarns will have to be made up into nettles and used for the grafting.

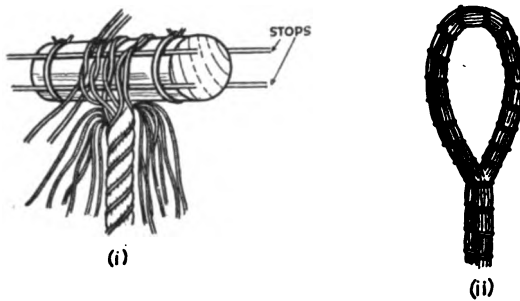


Fig. 71.—Making a Flemish eye

Rope Grommet

Cut a length of rope equal to three and a half times the circumference of the grommet required and then unlay the strands, being careful not to disturb their lay.

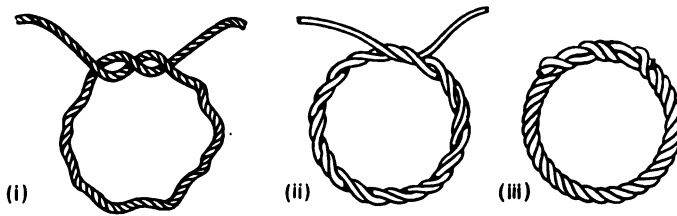


Fig. 72.—Making a rope grommet

Take one strand and bend it in the form of a ring of the size required, and then pass the ends round and round in their original lay to form a three-stranded grommet. Finish off with an overhand knot and tuck each end once on each side of the knot.

Notes (i) Each strand makes one grommet.

(ii) A strand from a right-handed rope makes a right-handed grommet.

To Fit a Becket to a Rope's End

Whip the rope at a distance from the end equal to three times its size, and unlay to the whipping. Select approximately one-fifth of the inside yarns from each strand, and stop the remainder back along the rope (see Fig. 73(i)). Then lay up the inside yarns in the following manner.

Hold the rope in the left hand, or in a vice, with the end pointing to the right.

With the right hand take the furthest set of yarns (all from the same strand) and twist them up in a direction away from the body. Then lay them across, and on top of, the other two. Securing the cross with the left thumb, repeat with the now furthest strand, and continue thus until all have been laid up (Fig. 73(i)).

Place a whipping on the relaid strands at a distance from their root equal to one and a half times the size of the rope. The end portion of the relaid strands need not be whipped and can be left for the present.

The rope forming the becket should be one quarter the size of the large rope or slightly larger ($1\frac{1}{4}$ -inch rope makes a good becket for a 4-inch rope); its length should be six times the size of the larger rope.

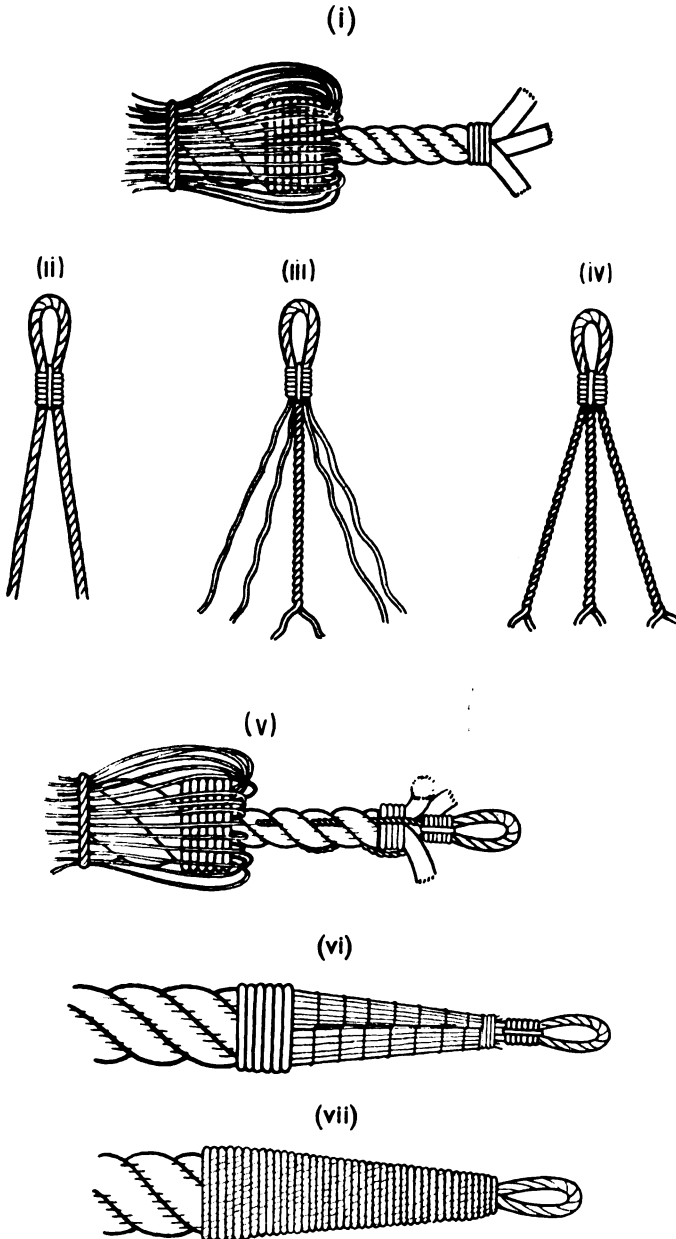


Fig. 73.—Fitting a becket to a rope's end

Middle the small rope and put on a twine seizing so as to form an eye with two legs hanging from it (Fig. 73(ii)) ; then unlay the legs to the seizing (Fig. 73(iii)). Lay up the strands in pairs, each pair consisting of one strand from each leg, thus making of the whole an eye with three legs (see Fig. 73(iv)).

Now marry the three legs of the becket with the relaid strands of the large rope and tuck twice as for a short splice, but leave the whipping in place. Cut off all ends, give the splice a twist to harden it up, and marl down (Fig. 73(v)).

Select sufficient outside yarns from those stopped back on the large rope to cover the splice, and cut away the remainder. Then marl down, cutting out a few inner yarns after each couple of turns of marling so as to produce a neat taper (Fig. 73(vi)).

Finally serve over, beginning at the end and close up to the becket (Fig. 73(vii)).

WORMING, PARCELLING AND SERVING

A rope or part of a rope is wormed, parcelled and served for three reasons :—

- (i) to protect its outer surface against wear from chafing ;
- (ii) to make its outer surface smoother, so as to prevent other ropes from chafing when led over it ; and
- (iii) with a steel wire rope, to protect the hands of those using it from the sharp ends of wire projecting from any splice in it.

Worming, parcelling, or serving is not necessarily water-tight or damp-proof, and there is a danger that damp may rot a rope so treated underneath its covering. Ropes so treated should therefore be inspected frequently for signs of deterioration.

Worming consists of filling in the spaces between the strands with lengths of spunyarn or small stuff laid along the lay of the rope, and its object is to make the rope smooth and round.

Parcelling consists of binding the rope with strips of tarred canvas. The strips should be from 2 to 3 inches wide and it is customary to bind them on in the direction of lay of the rope, working towards the eye. Each turn should overlap that preceding it by half the width of the strip, and the rope should first be well talloved.

When parcelling and serving a stay throughout its whole length the parcelling should be worked upwards from the eye of the lower splice to the eye of the upper splice, as this method affords the maximum obstruction to the entry of water.

Serving consists of binding a splice or a length of rope with close turns of spunyarn. Each turn is hove taut with a special serving mallet, which has a score in its head to fit the rope and a wooden handle about 15 inches long.

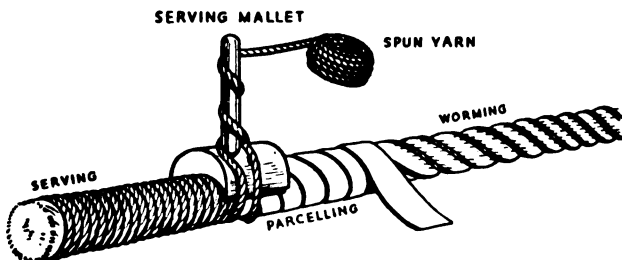


Fig. 74.—Worming, parcelling and serving

A service is always bound on in the opposite direction to the parcelling, so as to avoid bunching up the latter. It is therefore put on against the lay of the rope, which may be memorised thus :—

*Worm and parcel with the lay,
Turn, and serve the other way.*

A service is begun as for a common whipping, and for an eye splice it is usual to work from the splice to the eye. The first few turns are put on by hand and hauled taut with a spike or heaving mallet. The serving mallet is then placed on the rope and the turns of the service are passed as follows :—

take a half turn round the handle ; then one turn around both the fore end of the head of the mallet and the rope ; then dog the serving around the handle of the mallet.

Some mallets work better if a preliminary round turn is taken round the rope and after end of the head, and then followed by the turns described above.

To put on a service, stand with the rope on your left side while facing in the direction in which the turns are advancing. Then pass the ball of spunyarn round and round in step with the service.

Having completed the required length of service, finish it off by passing the end back under the last four turns, haul all parts taut, and make a crown and wall.

Notes (i) If serving over a restricted length of rope, up to an eye splice or Turk's head for example, which does not allow the mallet to advance ahead of the last turns, the spunyarn should be brought to the mallet as follows :—

up over the cut in the fore end of the head ; one quarter turn round the handle ; one turn round the rope and rear end of the head (taken in the direction of the service, *i.e.* against the lay of the rope) ; and then dogged round the handle.

(ii) Smear the rope or splice with tallow before beginning to serve, if it is not parcelled.

(iii) Services with flexible mild steel wire differ little from those with cordage.

KNOTS, AND GENERAL ADVANCED WORK IN CORDAGE

Knots

The functions of a knot are to prevent a rope from unreeving through a block or deadeye, or to provide a handhold, a weight, or a stopper on any part of a rope. Some knots are also used for decorative purposes.

To assist in describing how these knots are made, the convention has been adopted of lettering the strands, *A, B, C*, etc., and their respective bights, *a, b, c*, etc., so that *a* is the bight of *A*, *b* is the bight of *B*, and so on.

MANROPE KNOT

This is a decorative knot made at the end of gangway manropes to prevent them unreeving, and to afford a handhold for anyone climbing aboard.

To make the knot whip the rope at a distance from its end

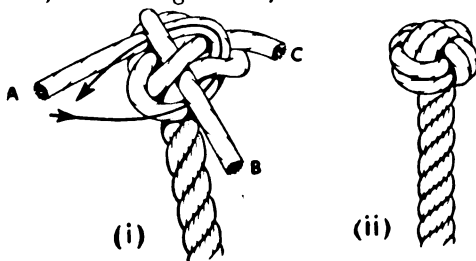


Fig. 75.—Manrope knot

equal to six times its size, unlay the rope to the whipping, and whip the ends of the strands.

Make a wall and crown, keeping the knot fairly loose.

Then, as indicated by the arrow in Fig. 75(i), take strand *A* and follow it round its own part, thus doubling up strand *A*.

Work the other two strands similarly and haul all parts taut (Fig. 75(ii)).

TURK'S HEAD

This is an ornamental knot supposed to resemble the turbanned head of a Turk, and should consist of three or more parts followed round two or more times.

It may be made either as a standing or a running knot, according to whether it is to be fixed to an end or a bight, or is to be formed round another part of rope, a stanchion, or an oar, for example.

The five different forms of this knot are as follows :—

(a) *Standing Turk's Head, made at the end of a rope.*

This is a manrope knot but the ends are followed round a third or fourth time. Before starting the knot, however, the strands must be unlayd for a distance of not less than eight times the size of the rope, and the whipping be placed accordingly.

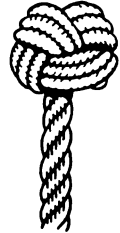


Fig. 76.—Standing Turk's head

(b) *Running Turk's Head made at the end of a rope and round its own bight* (as in a running lanyard) is similar to a standing Turk's head made at the end of a rope, except that the wall and crown with which it is begun are made round the bight of the rope. The strands are then followed round twice or more often, thus forming a running knot which will slide up and down the bight.

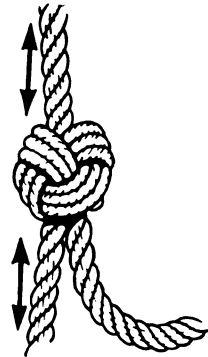


Fig. 77.—Running Turk's head

(c) *Standing Turk's Head, made on the bight of a rope* is formed from a three-parted length of line called a spider, which is tucked into the centre of the rope so that its parts emerge from the strands equidistantly.

The spider is made up by tucking a length of line into the bight of another line (Fig. 78(i)). The length of each leg should be not less than five or six times the combined circumferences of the rope and the line.

Having inserted the spider (Fig. 78(ii)), crown the ends round the rope left-handed (Fig. 78(iii)), and then turn round and crown them back right-handed (Fig. 78(iv)). Now follow each part round with its own end two or more times (Fig. 78(v)), work all parts taut, and the knot is completed.

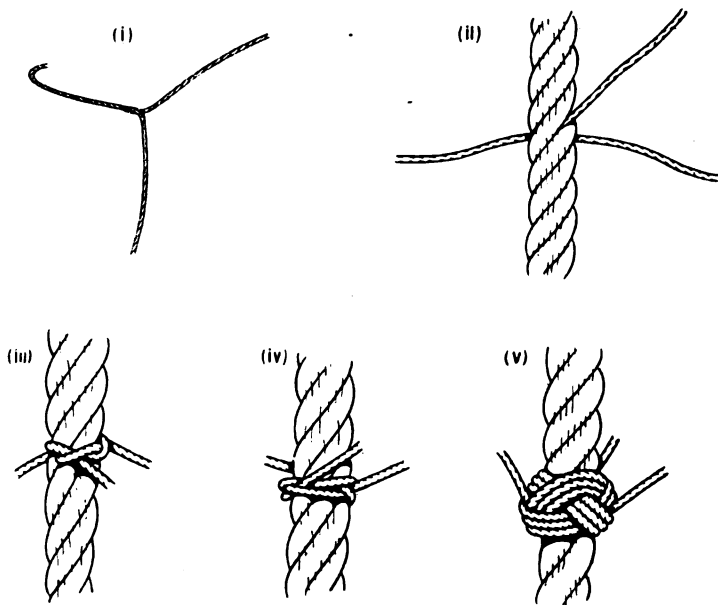


Fig. 78.—Standing Turk's head on a bight

(d) *Running Turk's Head, made round a bight of rope, a stanchion of other fitting is formed out of a single length of line as follows :—*

- (i) a half hitch is made round the rope or fitting, and then followed by a round turn ; the end is then dipped under the part of the half hitch (Fig. 79(i)) ;
- (ii) the bights round the rope are crossed, the bight which is on the same side as the end being placed underneath ;
- (iii) the end is then passed down between the bights (Fig. 79(ii)) and brought over the other side.

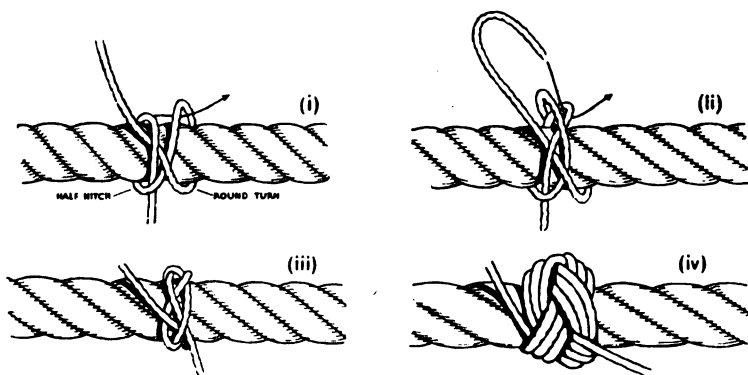


Fig. 79.—Running Turk's head on a bight

The second and third operations are repeated until the rope is encircled. The ends are then followed round as often as may be required, all parts are hauled taut and finished off with a crown and wall.

(e) *Multi-parted Turk's Head*.—The running Turk's head just described has three parts only, but one of four or more parts is a simple development of the same principle.

A multi-parted Turk's head is started as before with a half hitch and round turn; in other words two turns are taken round the object to be decorated, the end passing once over and once under the standing part (or non-working end). To make a four-parted Turk's head, a third turn is now taken, the end passing over the standing part. A fifth part can be obtained by a further turn, the end going under the standing part; and this can be continued, the end passing alternately over and under the standing part, as often as is required.

The end is now rove back through the turns the opposite way to the standing part. It is passed alternately over and under (or under and over), so as to keep on the opposite side of each turn to the standing part, under which it finally dips. The bight of the turn under which the end now passes is dipped under its neighbour, and then alternately over and under successive turns to emerge on the opposite side of the knot. Finally the end is rove in the same way, but keeping on the opposite side of each turn to the bight.

These running Turk's heads can be made round the hand and formed into a spherical knot, at the end of a heaving line, for example.

MATHEW WALKER

This knot is used to prevent a rope, such as a rudder lanyard, from unreeving, it is a development of the wall knot, is neater and more decorative than the wall and crown, and is easily made, as follows:—

- (i) make a bight with strand *A*, and pass the end round outside *B* and *C* (Fig. 80(i)) ;
- (ii) pass the end of *B* round outside *A* and *C* and up through *a* (Fig. 80(ii)) ;
- (iii) pass the end of *C* round outside *A* and *B*, as indicated by the dotted line, and then through *a* and up through *b* (Fig. 80(ii)).

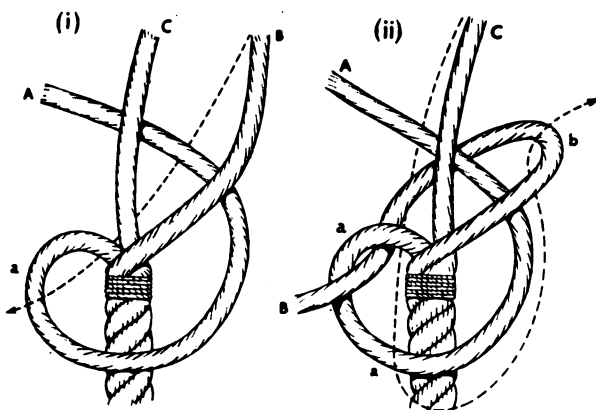


Fig. 80.—Matthew Walker knot

DOUBLE MATHEW WALKER

This knot is one step forward from the single Mathew Walker. It is made as follows:—

- (i) make a bight with strand *A*, then pass the end round strands *B* and *C* and up through its own bight *a* (Fig. 81(i)) ;

- (ii) make a bight with strand *B*, then pass the end round outside *A* and *C*, through *a*, and up through its own bight *b* (Fig. 81(ii)) ;
- (iii) make a bight with strand *C*, pass the end round outside *A* and *B*, through *a* and *b*, and then up through its own bight *c*.

In both single and double Mathew Walkers a strand taken through a bight already occupied by one or more strands passes through beneath those already in place.

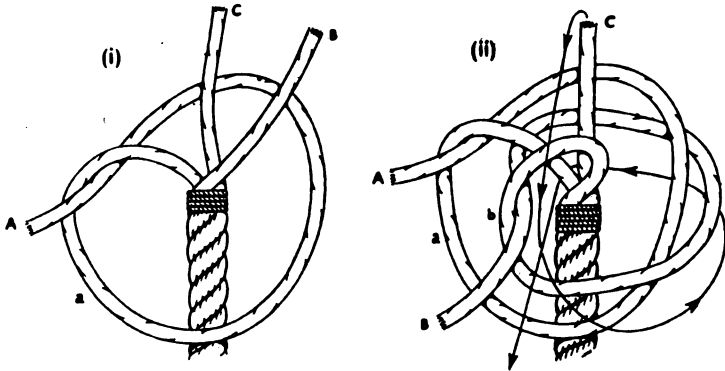


Fig. 81.—Double Mathew Walker knot

STOPPER KNOT OR DOUBLE WALL

As this knot produces a more pronounced shoulder than any of the others it forms a useful stopper on a rope to prevent anything passing beyond it. It is not so neat in appearance as some of the others because the ends of the strands protrude from the top of the knot, but it can be made on the bight as well as on the end of a rope and is often used in guest warps in place of the double diamond.

To make this knot, whip a rope at a distance from its end equal to four times the size of the rope and unlay to the whipping. Form a wall, as shown in Fig. 82, and then :—

pass *A* down and round *B*, and bring it up through *c* to the centre ;
 pass *B* down and round *C*, and bring it up through *a* to the centre ;
 pass *C* down and round *A*, and bring it up through *b* to the centre.

Now haul each strand taut at the top and in the centre of the knot, then whip all the strands together and cut off their ends evenly just above the whipping.

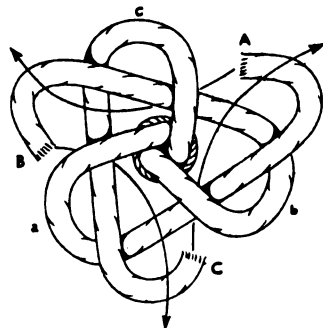


Fig. 82.—Stopper knot

MONKEY'S FIST

This is used to weight the end of a heaving line so that it will carry when thrown against the wind. In appearance it is very similar to a Turk's head, and takes from 6 to 9 feet of line. It is made as follows :—

- (i) wind three turns round the hand, as in Fig. 83(i) ;

- (ii) pass a second set of three turns across and round the first three, in the direction indicated by the arrows in Fig. 83(ii) ;
- (iii) pass a third three turns round and across the second three, but inside the first set and in the direction shown by the arrows in Fig. 83(iii) ; if the knot is correctly made the end will come out alongside the standing part.

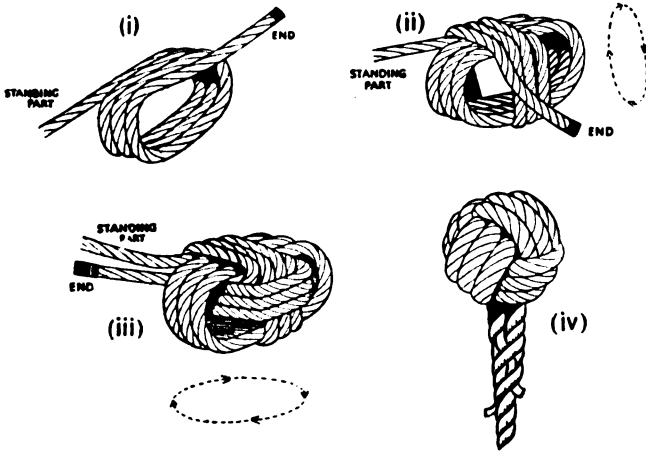


Fig. 83.—Monkey's fist

To finish the knot, work all parts taut and splice the end into the standing part ; alternatively, tie an overhand knot in the end and expend it by tucking it inside the monkey fist, then work all parts taut as before.

HEAVING LINE KNOT

This knot is used as an alternative to the monkey's fist, and is quickly and easily made.

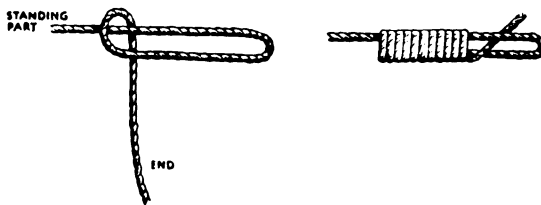


Fig. 84.—Heaving-line knot

Form a bight about 5 feet long at the end of the line. Start frapping the end around both parts of the bight at about 8 inches from the actual bend of the bight, and continue until it is all but expended. Then pass the end through the small loop left and haul on the standing part.

SIX-PARTED CROWN AND WALL

This is the foundation of the sennet knot and is made on exactly the same principle as a normal crown and wall, although it appears more complicated.

To obtain six parts from a three-stranded rope, whip the rope at the required distance from the end and unlay it to the whipping. Then unlay each strand,

divide each into two equal parts, and lay up and whip the end of each half strand (Fig. 85(i)).

To make the six-parted crown :—

take *A* over *B* (Fig. 85(ii)) ;

take *B* round *A*, and then over *C* (Fig. 85 (iii)) ;

take *C* round *B*, and then over *D* (Fig. 85 (iv)) ;

continue thus with *D*, *E* and *F*, and after taking *F* round *E* pass *F* down through the bight *a* (Fig. 85 (iv)).

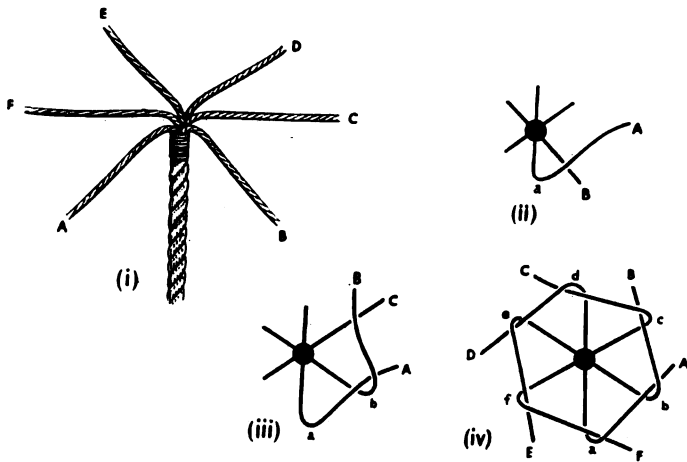


Fig. 85.—Six-parted crown

The six-parted wall is then formed as follows :—

take *A* under *B* (Fig. 86 (i)) ;

take *B* round *A*, and pass it under *C* (Fig. 86 (ii)) ;

take *C* round *B*, and pass it under *D* (Fig. 86 (iii)) ;

continue thus to *F*, and after taking *F* round *E* pass *F* up through the bight *a* (Fig. 86 (iii)).

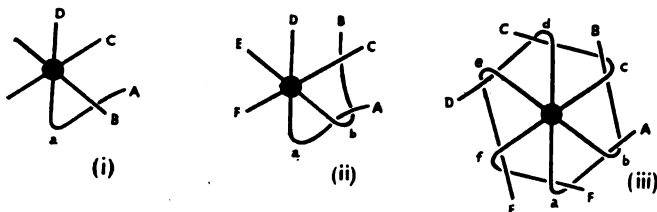


Fig. 86.—Six-parted wall

SENNET KNOT

Make a six-parted crown and a six-parted wall under it. Then pull each part up through the centre of the knot.

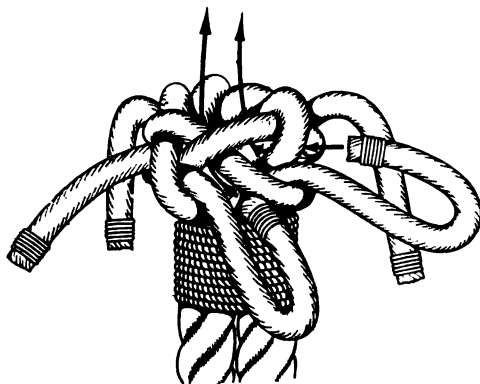


Fig. 87.—Sennet knot

DIAMOND KNOT

Whip the rope at a distance from its end equal to four and a half times the size of the rope. Unlay to the whipping and hold the strands so as to form three loops placed equidistantly round the rope, as in Fig. 88 (i), then :—

- take *A* round outside *B* and up through *c* ;
- take *B* round outside *C* and up through *a* ;
- take *C* round and up through *b* (Fig. 88 (ii)).

Then haul all ends taut and finish off.

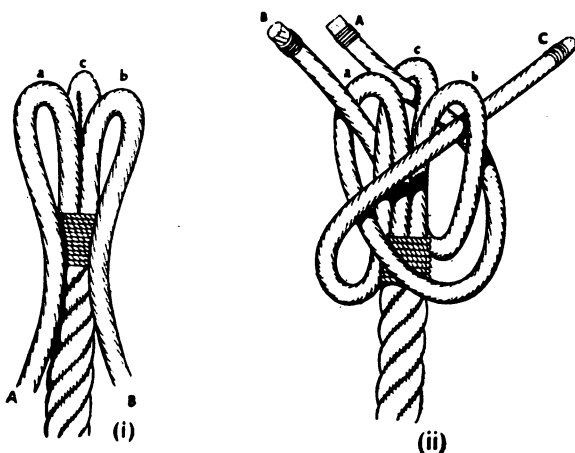


Fig. 88.—Diamond knot

DOUBLE DIAMOND

Whip the rope at a distance from its end equal to six times the size of the rope. Then make a single diamond knot and follow the ends round once.

Both single and double diamonds are often made on the bight of a rope (such as a guest warp) ; the rope is then whipped and unlayed to the point at which the knot is required, and laid up again when the knot is completed.

NETTLE OR FOX

This consists of two yarns, laid up together left-handed between the finger and thumb, as follows :—

the yarns are held between the finger and thumb of the left hand and pointing to the right ;

the nearer one is given a twist towards the body with the finger and thumb of the right hand ;

it is then laid across its fellow and the cross is secured with the thumb of the left hand.

This is continued until the required length of nettle is completed, when an overhand knot is made to prevent it unlaying.

A nettle can be similarly made from one yarn split in two.

TO POINT A ROPE

Whip the rope at a distance from its end equal to twice the circumference of the rope plus 6 to 8 inches, and unlay it to the whipping.

Select a number of outside yarns from each strand and make them up into an even number of nettles, making each nettle from one yarn split into two. When completed, stop the nettles back along the standing part of the rope. Then unlay the remaining strands and marl them down, cutting out a few centre yarns after each couple of turns of the marling so as to form a tapering heart on which to work the point (Fig. 89 (i)).

Unstop and divide the nettles, taking every other nettle down and back along the rope, and the remainder up and along the heart ; the former will now be called the lower nettles and the latter the upper nettles. Hitch a piece of twine (called the warp) with a couple of turns round the point where the nettles separate, and as close as possible to the lower nettles, leaving the end of the warp free to pass again (Fig. 89 (ii)).

Now bring the upper nettles down and the lower nettles up, and again pass the warp.

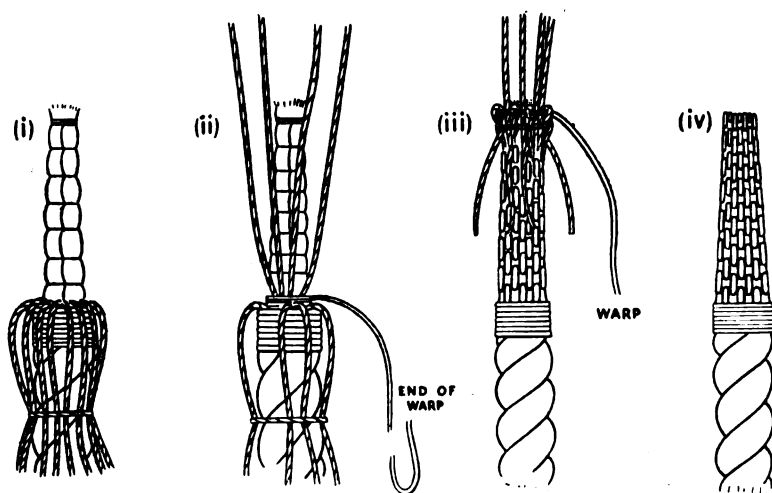


Fig. 89.—Pointing a rope

Repeat this process until the pointing is of sufficient length (one and a half times the circumference of the rope), and then finish off as follows :—

make a bight at the end of the point with each of the then upper nettles, so that the end of each bight lies back along the pointing, and pass the warp through these bights, binding the ends against the heart with a marling hitch (Fig. 89 (iii)) ;

twist the top of each bight so as to form a figure of eight, and pass several hitches with the warp through these upper loops ;

haul each loop taut with a small spike ;

haul taut all ends and cut them off ;

cut off the lower nettles, the end of the warp, and the end of the heart protruding from the point (Fig. 89 (iv)).

Coverings

GRAFTING

This consists of nettles worked as in pointing, but is used to cover the whole or any part of a rope instead of the end only. Pointing, incidentally, can be regarded as a special kind of grafting.

Grafting is often used to make an ornamental finish to an eye splice, as follows :—

tuck the strands once ;

select sufficient inner yarns to worm the eye, i.e. to fill in the spaces between the strands ;

make up the remainder into nettles and proceed as in pointing. This grafting should extend for one and a half times the circumference of the rope.

COACHWHIPPING

This is used as an ornamental covering for boathooks, stanchions, bellropes and similar fittings. It can be made up, with an even number of parts, from line, nettles, or alternate strips of blue jean and white duck, or any suitable decorative material.

Each nettle is secured to the fitting to be whipped by one end, so as to be spaced round it equidistantly ; in the following description of how this whipping is made the nettles have been numbered from 1 to 10.

There are different methods of making coachwhipping, and, according to the material used, it may be convenient to work either upwards or downwards, or in any direction. In this particular example, it has been decided to work upwards and to make the first cross to the right, but the instructions given below can easily be modified to apply to working the nettles downward or otherwise.

First, cross each odd numbered nettle over the even numbered nettle on its right, and hold or stop it up. Allow the even numbered nettles to hang downwards (Fig. 90 (ii)).

Cross each even nettle over the odd numbered nettle on its left. Hold or stop up the even numbered nettles, and allow the odd numbered nettles to fall downwards (Fig. 90 (iii)).

Cross each odd numbered nettle over the even numbered nettle on its right, hold or stop it up, and allow the even numbered nettles to fall downwards (Fig. 90 (iv)).

Continue thus until the desired portion of the fitting has been covered.

It will help if, on completion of each round, a stop of twine is passed round the upper nettles close to the cross. These stops are cut off when the work is finished.

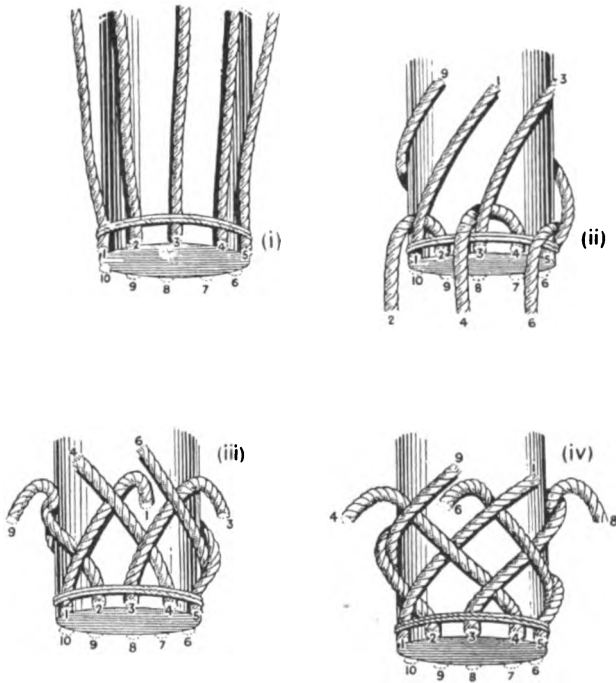


Fig. 90.—Coach-whipping

HALF HITCHING

This is used extensively on the bow fenders of tugs.

Splice an eye in a length of line and pass the end through this eye so as to form a ring round one end of the fender.

Pass the end up through this ring and pull it down through its own bight, thus forming one half hitch; repeat this operation as often as is required to surround the ring with a complete row of such hitches, taking care to work round in the direction in which the crown of the spliced eye is pointing (Fig. 91 (i)).

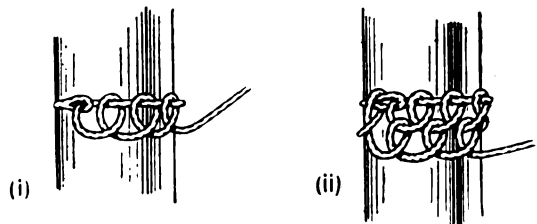


Fig. 91.—Half-hitching

Then form a second row, making a half hitch in each bight of the first (Fig. 91 (ii)), and then a third row and as many more as are required.

As the girth of the fender increases the number of hitches is increased by making two in one bight as often as necessary; as the girth decreases the number of hitches can be decreased by missing a bight periodically.

CONTINUOUS WALLING

This is used as an alternative covering for a fender, or for decorating stanchions and other fittings. It uses less material than half hitching.

It is made from a number of nettles, or of lengths of suitable line or rope, each secured by one end to the fitting to be covered so that they are spaced round it equidistantly. The fitting, a fender for example, is secured so that the nettles hang downwards, and it is then covered by a series of wall knots, each being made from the nettles as already described for a six-parted wall, *i.e.* :—

pass *A* over *B* ;
bring *B* up and over so as to enclose *A*,
and place it over *C* ;

bring *C* up and over so as to enclose *B*,
and place it over *D* ;

continue in this manner until the last nettle is eventually passed down through a ;
then haul the whole row taut and repeat the operation as often as necessary.

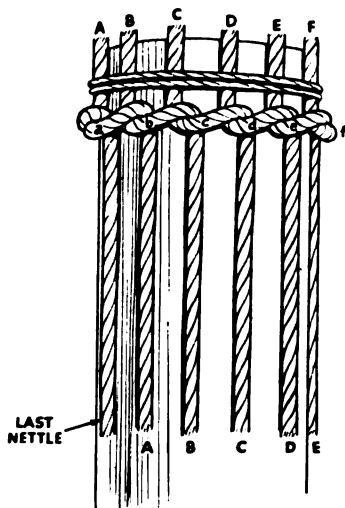


Fig. 92.—Continuous-walling

If the fitting to be covered is not of even diameter it is usual to begin continuous walling at the largest girth, and then to decrease by discarding nettles as necessary.

RINGBOLT HITCHING

This is used to cover an eye and is frequently used on circular fenders; it is made as follows :—

- (i) middle the length of line and make a clove hitch round the eye (Fig. 93 (i)) ;

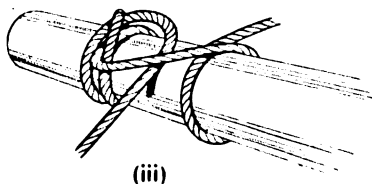
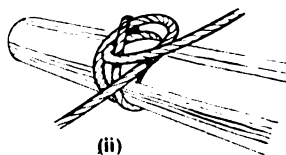
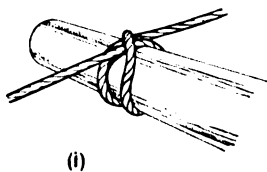


Fig. 93.—Ringbolt-hitching

- (ii) cross the right part under the left and take it clear, as in Fig. 93 (ii) ;
and
 - (iii) make a half hitch with the new right part (Fig. 93 (iii))
- Repeat (ii) and (iii) as often as is necessary to cover the eye.

Net Making

The nets most commonly used in the Royal Navy are cordage and wire rope provision nets for handling provisions and stores in bulk, and wire rope jumping nets.

CORDAGE PROVISION NET

The net is made on a jackstay of 8 fathoms of $2\frac{1}{2}$ -inch tarred sisal, and the mesh consists of about 120 fathoms of $1\frac{1}{4}$ -inch tarred sisal. The mesh can be passed with the complete coil, but this is a cumbersome method, especially with tarred sisal, because it necessitates taking out the turns which are put in the rope as the mesh is formed. For this reason it is simpler to pass the mesh with 30-fathom lengths, stretched and then coiled with a clove hitch around the middle, each length being long-spliced to the next.

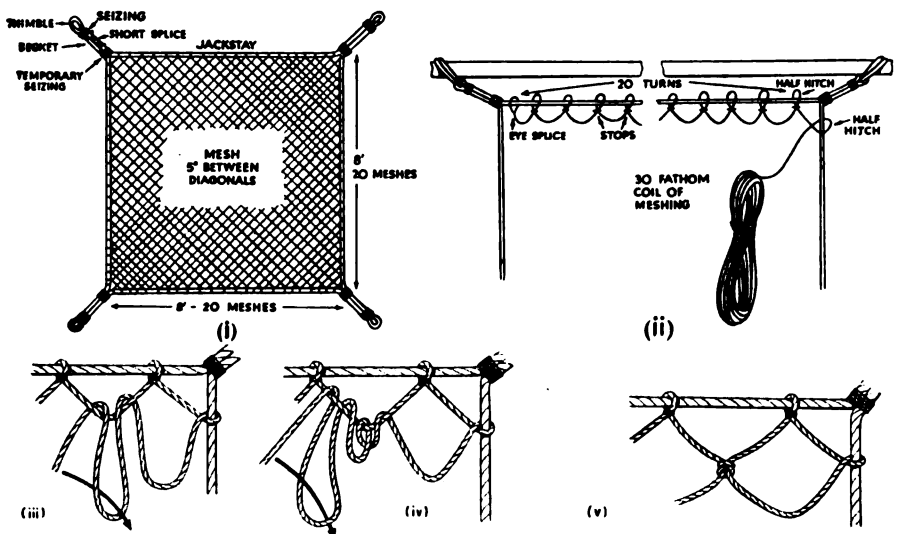


Fig. 94.—Making a cordage provision net

To form the jackstay put it on a stretch, marry it at 44 feet, and join the ends with a short splice. Lay this out in a square with the splice near one corner, and seize a round thimble (patt. 652) into each corner with a round seizing of $\frac{1}{4}$ -inch tarred sisal, using six turns over seven. Close in the square to sides of 8 feet in length and put temporary seizings at the four corners, making four beackets each $1\frac{1}{2}$ feet in length.

Now lash the beackets of one side of the jackstay to a spar at head level. Put a 30-fathom length of mesh on a stretch, coil it, and secure its first end to the top left hand corner of the jackstay with an eye splice and stop it in place. Then take twenty turns of the mesh round the top side of the jackstay, working to the right, and space them evenly throughout its length (Fig. 94 (ii)). Secure each turn with a light stop, with the bight between each turn one hand's breadth in depth. The last turn is half hitched and then half hitched to the

side of the jackstay, and the mesh is then worked back to the left in the following manner :—

The bight of the coil is passed up through the first bight of mesh and the coil is passed up through the bight so formed (Fig. 94(iii)). The bight of the coil is then passed down through the same bight of mesh, and the coil is passed down through the bight thus formed (Fig. 94(iv)). The parts are hauled taut and it will be found that a mesh has been formed with a reef knot at the cross (Fig. 94(v)). The mesh thus formed should be 5 inches from corner to corner, and, after some practice, this can be judged by eye.

The mesh is continued to the left in the same way, and the first row is formed and finished, with a half hitch round the first end and another half hitch around the left side of the jackstay, before continuing with the second row of mesh to the right.

The mesh is then continued, by working right and left between the sides of the jackstay, until twenty successive rows of mesh have been formed ; each 30-fathom length of mesh is joined to the next with a long splice. The last turns of the mesh are passed round the bottom side of the jackstay in the same way as the turns were passed round the top and sides, and the mesh is finished off at the bottom left hand corner with a clove hitch and an eye splice.

WIRE ROPE PROVISION NET (Fig. 95)

The net is made on a jackstay of 9 fathoms of $1\frac{1}{2}$ -inch F.S.W.R., which is married at 46 feet and has its ends long-spliced together. The jackstay is closed to a square with sides 8 feet in length, and a becket 18 inches in length is formed at each corner. Each becket is seized at its throat and middle to form a soft eye about a foot long. Each seizing consists of eight turns of $\frac{3}{8}$ -inch seizing wire.

The jackstay is pegged out on a frame, or on a flat surface, and pegs are driven in at intervals along the sides on which to form the mesh. The mesh is 6 inches square and made of 50 fathoms of 1-inch F.S.W.R. In spacing the pegs the diameter of the mesh rope must be taken into account ; the pegs are therefore driven in, in pairs, at a distance apart of 5 inches, and with a distance between pairs of 7 inches, there being eighteen pegs, including the corner pegs, to a side.

The first end of the mesh is eye-spliced round the jackstay 6 inches from one corner, then taken to the opposite side, over the jackstay, round the first peg, and then round the second peg and under the jackstay. Thence it is taken back to the opposite side, over the jackstay, round the first peg, and then round the second peg and under the jackstay. The mesh is seized to the jackstay at each peg with an eight-turn seizing of $\frac{3}{8}$ -inch wire. This sequence is continued until all the rows in one direction have been completed.

The mesh is then taken round the corner peg and round the first peg of the adjacent side, whence it is passed across to the opposite side, working alternately over and under the rows already passed. The meshes are seized where they cross with $\frac{3}{8}$ -inch seizing wire crossed four times. The mesh is continued until the net is filled, and the last end is eye-spliced around the jackstay.

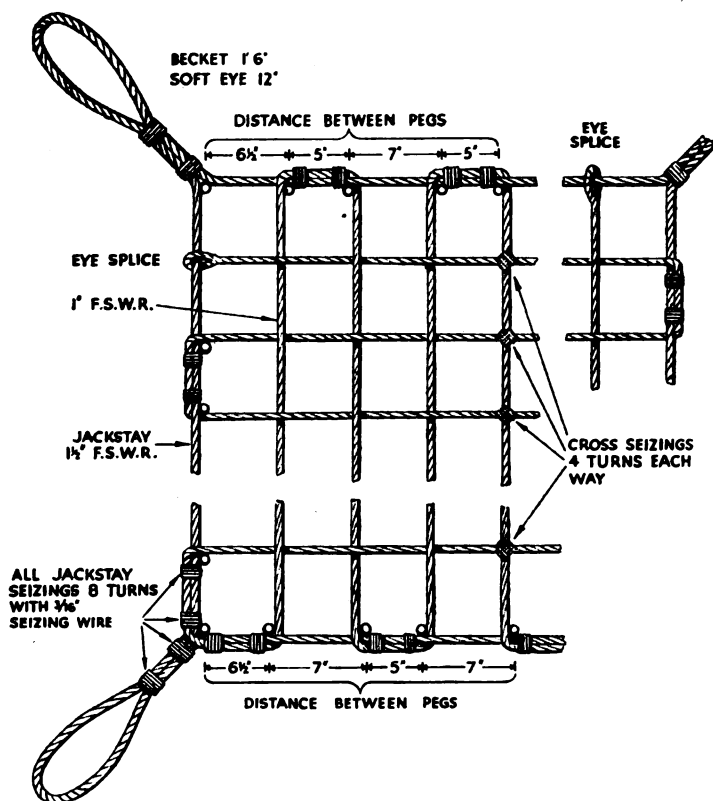


Fig. 95.—Making a wire rope provision net

WIRE ROPE JUMPING NET

This is made in a similar manner to the provision net, except that :—

- (i) instead of becketts, a pattern 1917 thimble is seized into each corner of the jackstay ;
- (ii) the across meshes are rove through the strands of the up-and-down meshes before being cross-seized ;
- (iii) the jackstay is 2-inch F.S.W.R. and the mesh is $1\frac{1}{2}$ -inch F.S.W.R. ;
- (iv) the size of the mesh is 8 inches square.

SPLICING WIRE ROPE

Wire rope is spliced in accordance with the same principles as fibre rope, but wire being much less tractable greater skill is required and particular care must always be taken with whippings and seizings.

It should also be remembered that the bending of the wires during the process of splicing may injure their galvanised surface ; when possible, splices should therefore be dipped in Stockholm tar, or some other similar preservative such as mineral tar or tallow, before being parcelled and served.

All splices reduce the strength of wire rope by approximately one-eighth, but a badly made splice will reduce it appreciably more. The less the strands are distorted and disturbed when tucking the less will be their loss of strength ;

also the splice must be carefully tapered from its beginning at the eye (or "marry") down to the extreme ends of the last strands tucked. Though it is sometimes claimed that the long splice causes no loss of strength it is advisable to make the same allowance for it as in other splices.

There are several ways of doing some of the operations here described, especially that of making the first tuck of an eye splice, but there appears to be little to choose between them as regards their effect on the strength of the rope, and appearance is a matter of taste. The methods described here are those used in the Royal Navy.

A marline spike with a long tapered point should be used to open the strands; the correct way to use it is best demonstrated by an instructor, but proficiency will not come without practice. The spike should be inserted before each strand is tucked, and not be withdrawn until that tuck is complete. The tucking strand is passed through the rope in the same direction as, and beyond, the spike, and it is then pulled into place in the splice.

The twisting and pulling caused in tucking the strands tends to distort their natural set and must be reduced to a minimum. It is greatest when the strands are inserted close to the point at which they emerge from the last tuck (*i.e.* with a "short nip"), and it will be found that they will usually go more kindly into place if the spike is introduced under the correct strand but some inches farther down the rope. The tucking strand should then be passed through, as already described, and hauled into place while working the spike back along the lay of the rope. The less the strands are distorted the neater and stronger will be the splice.

In the Royal Navy all tucks are made *against* the lay of the rope.

Unless otherwise stated (*e.g.* as in the directions for making an eye splice), the mention of the left or right side of a rope applies when looking along the rope towards its end.

When making all the splices described here the ends of the strands must always be whipped before they are unlaidd.

To Make a Short Splice

Put a stout whipping on each rope at a distance from its end equal to twelve times its circumference, securely whip the ends of the strands, unlay to the whippings, and cut out the heart thus exposed.

Marry the two ropes so that each strand of one lies between two of the other, hitch a line to the strands of each rope and haul the marry as taut as possible with a tackle or Spanish windlass, occasionally tapping the strands with a maul to assist them to settle in. It is a general rule that, when married, the distance between the two whippings for a short splice in wire rope should be a little more than half the size of the rope.

Seize the strands on one side of the marry to the standing part on the other with a strong seizing; having hauled the first turns taut with a heaving mallet it is advisable to put on the remainder with a serving mallet as for a serving. Cut the whipping on the opposite side of the marry and begin tucking. As with fibre rope, each strand is taken over the strand on its left and tucked under the next one, and it emerges between the latter and the subsequent one.

Having tucked each strand on that side of the marry once, place a seizing outside these tucks to prevent them easing back during the subsequent stages,

and then unlay each strand and cut out the core if of jute or hemp ; if of wire, however, the cores are not removed. Then lay up the strands again.

Tuck these relaid strands again, three times for rope of size 4 inches or less, and four times for rope of above 4 inches in size. Then take one-third out of each strand and stop it back. Tuck the remaining two-thirds once, and then stop back half of each. Tuck each of the one-third strands once and then tap down all tucks with a mallet, starting from the first tuck and finishing off at the tail, to remove any slack and to round-up the splice. Then break off all ends, including those stopped back, by bending each separate wire to and fro ; though broken off short, a small hook is thus formed in the end of each wire which will prevent it from drawing.

Now remove the seizings and cut the whippings from the other side, and tuck the strands on that side in the same manner. After rounding-up the whole splice the tapered parts of it should be served so that all wire ends are covered.

To Make a Long Splice

Whip each rope at a distance from its end equal to thirty-six times its circumference, unlay to the whippings and cut out the hearts thus exposed. To assist in dealing with the long lengths of strands involved, some of which lengthen in the process of splicing, both ropes must be further prepared before marrying by whipping and cutting every other strand so as to reduce it to a convenient length of between 6 and 12 inches.

Marry the ropes so that each short strand has a long strand from the other rope on its right and a short one from the other rope on its left. As in the short splice, haul the marry very taut, seize the long strands on one side to the standing part, and cut the whipping on the other side.

Unlay one short strand and follow it up with the long one from the opposite rope, which lay on its right in the marry, until reaching a distance from the marry equal to thirty times the circumference of the rope. This requires more knack than with fibre rope, and when once started it will help if each pair of ends is crossed so that each now has the other on its left instead of its right. Crossing a pair of strands also has the effect of locking them so that they will not unlay and will therefore remain in place when let go. Now take the second pair of strands, and then the third, and lay them up in the same manner, but lay up the second pair to a distance from the marry equal to eighteen times, and the third pair to six times, the circumference of the rope.

Remove the seizing from the rope on the other side of the marry, cross each pair of strands to lock them, cut the whipping, and repeat the above operation on the rope on this side. The result will be six pairs of strands equally spaced from each other at a distance equal to twelve times the circumference of the rope.

To finish, each end can be taken over its opposite number, tucked under two strands, and then broken off. To make a neat job, however, the ends of the strands should be buried inside the rope, the heart being cut out where each strand is buried and the buried strand taking its place. This finish requires more skill, and is carried out as follows (see Fig. 96) :—

Take end A over its opposite number B and tuck it under three strands ; the temporary whipping shown in Fig 96 (i) will help to hold the ends in place when the tuck is made. Insert the spike under the next three strands,

pull out the end of the heart, and bring round the strand just tucked so that it lies on the under-side of the spike (Fig. 96 (i)). (As it is very difficult to insert a spike under more than two strands a second spike must be used when tucking under three strands, the first being withdrawn after inserting the second under all three strands.) Now work the spike along the rope with the lay, pulling out the heart, and it will be found that the end below the spike is forced into the centre of the rope in place of the heart (Fig. 96 (ii)). Repeat this operation with the end of the second strand, but instead of first taking it over one strand and under three, cut the whipping, insert the spike under three strands, and bury this end as already described (Fig. 96 (iii)).

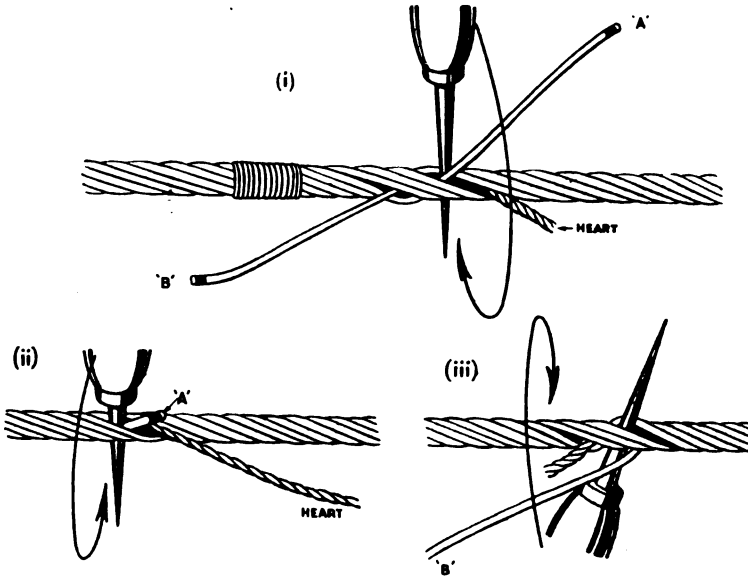


Fig. 96.—Finishing a long splice

On completion the two strands will be lying side by side where they disappear into the centre of the rope, making a very neat finish.

Each of the six pairs of strands are treated similarly, and, when completed, the buried ends should have replaced the heart for the whole length of the splice, a distance of seventy-two times the circumference of the rope. The lengths of the ends must be adjusted individually so that they just do not butt.

To Make an Eye Splice

Whip the rope at a distance from its end equal to twelve times its circumference. If a soft eye is required unlay the rope to the whipping before forming the eye; but if a thimble eye is required, first "break in" the rope around the thimble, as described below.

For convenience in the following instructions the strands are numbered from 1 to 6, the top strand being No. 1. Also, the parts of the rope are distinguished by naming them the "standing part" and the "tucking end", which terms are self-explanatory, and all references to the right and left apply only when looking down the rope from the crown of the eye.

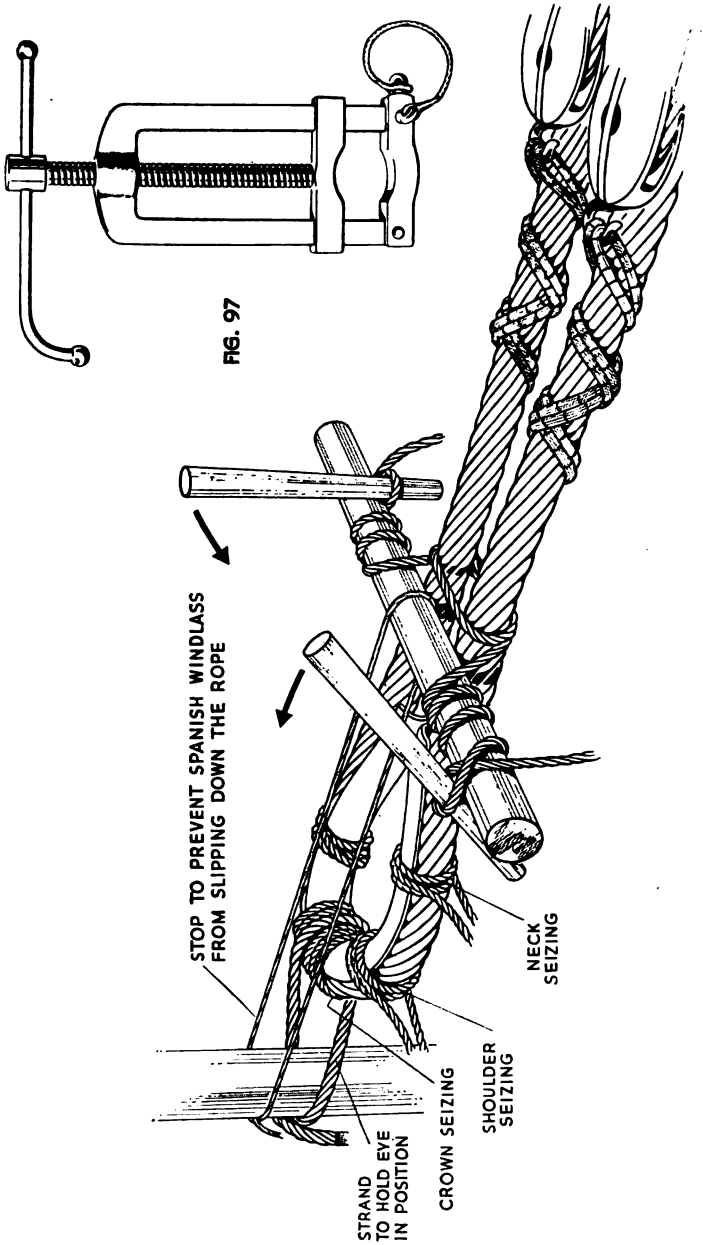


Fig. 98.—Breaking in a large wire rope round a thimble. (Inset : Fig. 97. A turning-in screw)

When ready for splicing, place the eye so that the tucking end lies to the left of the standing part, thus enabling No. 1 strand to be inserted from the right-hand side and against the lay.

Tuck No. 1 strand accordingly, under the strand immediately below it. Then tuck numbers 2, 3 and 4 under successive strands of the standing part, and then No. 6 under the *next two*. Finally, tuck No. 5 so that it emerges between the two strands under which No. 6 lies and after passing under one strand only. This will result in the six strands emerging equidistantly around the standing part, the variation in the regular sequence of tucking being necessary to make a neat splice.

Having completed one tuck with each strand, seize and tuck as for a short splice so as to complete the number of full tucks required for the size of the rope. Then reduce the strands and finish as for a short splice.

To Break-in a Rope Round a Thimble

A "turning-in screw" (Fig. 97) is supplied to the Royal Navy, in two sizes, for breaking-in a wire rope round a thimble. If such a device is not available the larger wire ropes can be broken-in in the manner described below and illustrated in Fig. 98.

Find the position on the rope which will lie at the crown of the thimble and seize the rope firmly into the crown at this point. Then secure the thimble and haul the rope into the form of a U, as close round the thimble as possible.

Rig a Spanish windlass on the two parts of the rope below the neck of the thimble, so as to haul them together. It will be necessary to put a light stop on the roller or bar of the Spanish windlass to counter the tendency of the windlass to slip down the rope as the parts come in.

Bind the rope close in to the thimble at each shoulder, and at each toe, with seizing stuff; each of these seizings should be secured on the inside of the thimble with a clove hitch. Haul the seizings taut with a heaving mallet, then walk back on the Spanish windlass and take it clear.

"Sweat up" first the shoulder seizings and then the toe seizings with a heaving mallet, as follows: after every heave take another turn with each part round thimble and rope, heave again, and repeat until the seizing is of sufficient size and the rope lying snug against the thimble at that point; then secure it and sweat up the next seizing. An occasional tap with a maul during the final stages will help to settle the rope into its place around the thimble.

An alternative to the Spanish windlass when using small and medium wire rope is to cross the parts and press the cross against a stanchion or other fixture, as in Fig. 99 (i).

Having thus closed in the parts as far as possible, pass a seizing round the cross. If the parts are now uncrossed and laid side by side, as in Fig. 99 (ii), the rope will be found to fit fairly snugly round the thimble.

Finally, put on the two seizings and complete the join with a heaving mallet.

When breaking in small and medium sized wire ropes it is not necessary to use the shoulder seizings, and an ordinary vice can be of great assistance.

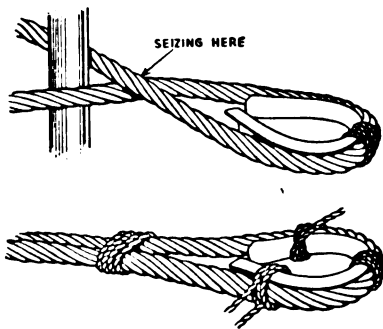


Fig. 99.—Breaking in a small wire rope round a thimble

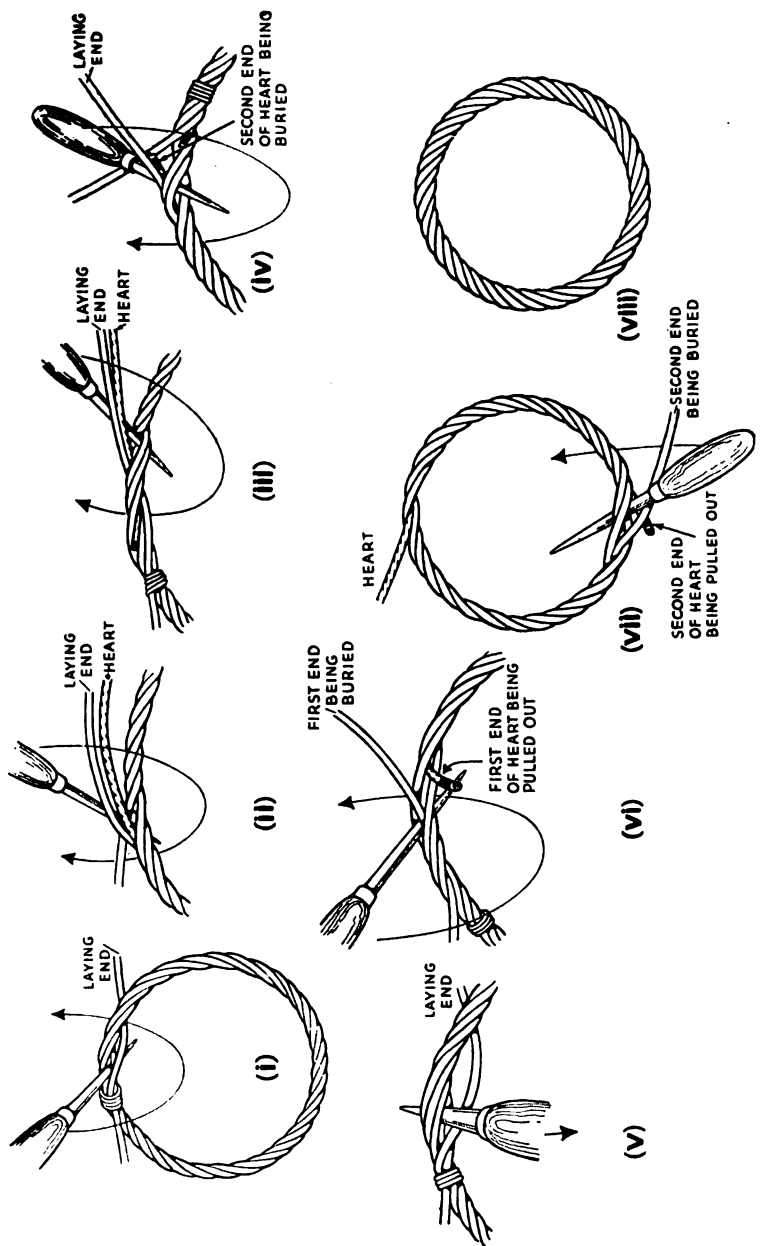


Fig. 100.—Making a wire grommet strap

Grommet Strops

The simplest form of grommet strop is known as a two-parted strop and is made from a single strand formed into a ring and laid up round its own part until the ends meet again. If the ends are taken round a second time the result is a three-parted strop, and so on until a six-parted strop is achieved. In practice, however, only three, four and six-parted strops are used.

To make the various grommets the following lengths of strands are required :

three-parted strop : circumference of strop $\times 4$;

four-parted strop : circumference of strop $\times 5$;

six-parted strop : circumference of strop $\times 8$.

To make a strop, marry the strand so as to form a ring of the required size and lay it up as described above ; a strand from a right-handed rope should, of course, be laid up right-handed. With a strop of not more than three parts this can be done with the fingers, but care must be taken to keep the strand in its natural lay, particularly the second time round.

At any stage of these operations only one end of the strand is being laid up, and for purposes of description this will be called the laying end. The other, or non-laying end, will have to be held in place either by a stop or by hand until the ends cross again.

A three-parted strop can either be finished off by taking each end over its opposite number and tucking it under two parts, or it can be carried on to make a four-parted strop. Laying up of this fourth part will require the use of a spike. Stop the non-laying end and insert the spike under two parts of the strop, close to where the ends cross, so that the third part and the laying ends lie beneath it (Fig. 100 (i)). Work the spike along with the lay and the new part will fall into its place correctly.

The four-parted strop can be finished off in a similar manner to the three-parted strop, or it can be carried on to make a five-parted strop. This step, however, involves the introduction of a heart and requires a higher degree of skill (see Fig. 100 (ii), (iii) and (iv)). As before, insert the spike under two parts of the strop. Take another length of strand equal to the circumference of the ring and insert one end into the centre of the strop, beneath the spike, to form the heart. The laying end of the strop is also placed beneath the spike, but must always be kept outside the heart or it will tend to take its place. The non-laying end is held in place by a stop. Work the spike along with the lay, and, with care, the heart will disappear inside the strop and the laying-up end take up its own place as the fifth part. Before its last end disappears it is most important that the length of the heart should be adjusted so that the ends do not butt. If correctly laid up a gap will show between two of the parts of the heart of a five-parted strop, and this gap will be occupied by the sixth part on completion of the final round.

To lay up the sixth part of the strop, first stop the non-laying end. Then insert the spike under three parts, close to where the ends cross, and place the laying end beneath it (Fig. 100 (v)). Work the spike along the lay, thus persuading the sixth part into place, and, at the same time, watch the heart carefully for any inclination to come out. It is a matter of choice whether to have the spike under or over the heart.

The strop is now finished as for a long splice, a portion of the heart being pulled out and replaced by the remaining ends of the original strand (Fig. 100 (vi) and (vii)). These ends must be adjusted so that they just do not butt.

There is an alternative method of making a grommet in which a pair of strands instead of a single strand is worked in the same manner, thus forming a four or six-parted strop, as required. This method has the advantages of being economical in material and making possible a somewhat longer strop, but more skill is required and it is not intended to describe it in detail.

The theoretical strength of a grommet strop can be calculated from the size of the strand from which it was made and the number of its parts. For example: a four-parted strop made from a strand of $2\frac{1}{2}$ -inch F.S.W.R. (breaking stress 13 tons) would have a theoretical breaking stress of $4/6 \times 13 \times 2 = 17.3$ tons.

Under normal conditions, and provided that it is not subjected to a particularly bad nip, a properly made grommet strop can be relied on to have a strength of 60 per cent. of its theoretical breaking stress. A useful rule-of-thumb is that a doubled, four-parted, grommet strop will be amply strong for joining two wire hawsers of a size half an inch larger than the rope from which the strop was made. For joining two $4\frac{1}{2}$ -inch wire hawsers, for example, a double, four-parted grommet strop made from a strand of 4-inch F.S.W.R. would be suitable. The connection can be made with a joining shackle, or for a full due by means of two cow hitches.

The Reduced Eye

This eye is largely used for attaching the inner end of a wire rope whip to the drum of a motor bollard, and so it should be as flexible as possible. There are several methods of making it, but the following one is very neat, and flexible right up to the crown of the eye. The splice is stronger than the eye, the latter being reduced about 75 per cent. of the strength of the rope.

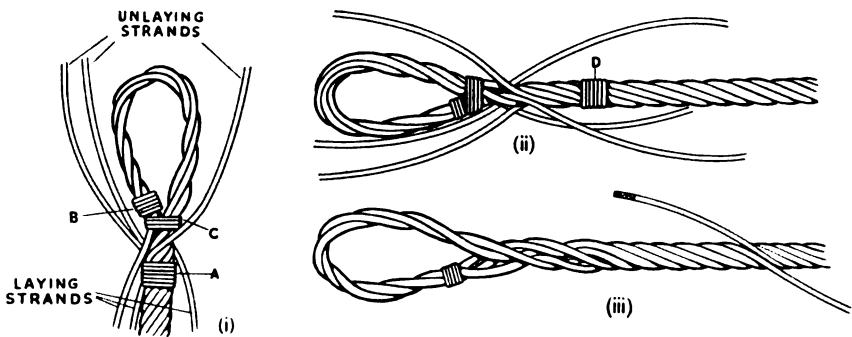


Fig. 101.—Making a reduced eye

Place a strong whipping *A* at a distance from the end equal to forty-two times the circumference of the rope plus the intended circumference of the eye (see Fig. 101 (i)). Unlay alternate strands to this whipping, having first whipped their ends; these strands will hereafter be referred to as the "unlaying strands". Cut out the heart, leaving the remaining strands still laid up into a three-stranded rope.

Place a second whipping *B* on this three-stranded rope at a distance from whipping *A* equal to the intended circumference of the eye. Unlay the strands (hereafter referred to as the "laying strands") to this whipping, having first

whipped their ends. Bend the three-parted rope to form the eye, so that each laying strand lies between two unlaying strands, and marry them up firmly.

Put on a seizing *C* to hold the marry in place, and cut whipping *A*. Put on a third whipping *D* about 3 inches below the marry (see Fig. 101 (ii)).

Tuck each laying strand under one strand of the three-parted rope and against the lay, as in Fig. 101 (ii), so that it emerges in a suitable position to follow up one of the unlaying strands, as in a long splice; then cross each pair of strands to lock them, and cut whippings *B* and *D*. The neatness of the finished job largely depends on the care with which the strands under which the laying strands are tucked have been selected; if carelessly selected the resulting splice will be long-jawed.

Finally, unlay and lay up each pair of strands as in a long splice (Fig. 101 (iii)) to distances from the marry of:—

thirty-six times the circumference of rope,

twenty-four times the circumference of rope,

twelve times the circumference of rope, respectively,

and then finish as for a long splice.

The Hawser Eye

In a hawser eye the wire rope is parcelled and served where it fits round the thimble. The thimbles shown in the following table are made large enough to allow for this, but the new range of thimbles (Pattern Nos. 5090-5095) are made to fit the bare rope, and if one of these is used a size one inch larger than that of the rope must be selected; for example, a hawser eye in $3\frac{1}{2}$ -inch F.S.W.R. will require a $4\frac{1}{2}$ -inch new pattern thimble.

THIMBLES AND SEIZINGS FOR WIRE ROPE EYES

SIZE OF WIRE ROPE	PATTERN NO. OF THIMBLE	SIZE OF SEIZING WIRE	NO. OF TURNS
$2\frac{1}{2}$ -inch	1918	$\frac{3}{8}$ -inch	12
3 "	1919	$\frac{3}{8}$ "	12
$3\frac{1}{2}$ "	1920	$\frac{3}{8}$ "	14
4 "	1921	$\frac{3}{8}$ "	14
$4\frac{1}{2}$ "	1922	$\frac{3}{8}$ "	14
5 "	1923	$\frac{1}{2}$ "	18
$5\frac{1}{2}$ "	1924	$\frac{1}{2}$ "	18
6 "	1925	$\frac{3}{4}$ "	18
$6\frac{1}{2}$ "	1926	$\frac{3}{4}$ "	18

Having selected the correct thimble for the size of rope, whip the rope as when preparing for an eye splice, and from this whipping measure along the rope a distance equal to the circumference of the rope plus one and a half times the length of the groove in the thimble. This gives the position for the first tuck.

Parcel and serve the rope from the whipping to the position for the first tuck, then form the eye and tuck and finish as for an eye splice. On completion the splice itself should be parcelled and served, using three-yarn spunyarn for the service if the rope is 4-inch or less, and four-yarn spunyarn if more than 4-inch.

Finally, insert the thimble and seize it in place with a flat seizing, using the number of turns and size of seizing wire indicated in the table. It may be necessary to use a Spanish windlass for hauling the parts together.

To Make a Bale Sling Strop

Take a length of wire rope and join the two ends together with a short splice. Before marrying, *take a half turn out of the rope*, otherwise the strop will tend to form a figure-of-eight. Parcel and serve over the splice.

To Make a Bollard Strop

Work the rope as for a bale sling strop, marrying at 14 feet. Tuck each side four times, breaking down the strands after each tuck, as follows :—

- make the first tuck with the whole strands ;
- make the second tuck with whole strands, less their jute cores ;
- make the third tuck with 2/3rd strands ; and
- make the fourth tuck with 1/3rd strands.

Serve the splice and then break it in symmetrically round a thimble, which must be seized in place with a round wire seizing. The thimble selected should, if possible, be some four sizes larger than the normal thimble for the rope used to make the strop ; a strop made from 3½-inch F.S.W.R., for example, would need a thimble designed for 5½-inch F.S.W.R. It is sometimes necessary slightly to open the groove of the thimble in order to take the splice.

To Splice Cordage into Wire Rope

This is necessary for dressing line whips, and W/T aerial halyards.

Unlay the wire rope as for a short splice, keeping the strands in pairs, and remove the heart. Splice the wire and rope together as for three-stranded rope. Marl down and serve over.

Wire Seizings

Seizings with flexible mild-steel wire are made in exactly the same manner as described at the beginning of this chapter for cordage seizings, except that the methods of starting and finishing are different.

Instead of passing the seizing stuff through a spliced eye a wire seizing is started by taking the end round one of the ropes to be fastened and then half-hitching it round its own part ; and it is finished by breaking off the ends of the wire as for a short splice in wire rope.

A metal covered heaving mallet is used for wire seizings, and, after each heave, the mallet should be run up and down the part of the wire that has been round it, in order to " clean out " the turns.

Wire Services

A wire service is started and applied in exactly the same manner as a spunyarn service, but with the larger sizes of flexible mild-steel wire it may be necessary to stop the first end down to the rope until sufficient turns have been applied to hold it firmly.

Also, it is customary to finish the service of an eye splice in a similar manner to that of a seizing ; a cross turn is therefore taken round the last few turns of the service, inside the neck of the eye, and is followed by a clove hitch, the ends of the wires being then broken off by twisting and then carefully tucked away so that no harm will result when the rope is handled.

HAWSERS

As its name implies, a hawser was originally a heavy fibre rope which was led through the hawse-pipes for use with the ship's anchors or for towing. Nowadays the term is applied to any long length of heavy rope, made of fibre or wire, which is specially fitted and supplied to a ship as part of her outfit and is used for heavy duties such as towing, berthing and warping ship.

Handling Hawasers

GENERAL PRECAUTIONS

- (i) Think out in advance where a rope will lead when it takes the strain. If likely to chafe anywhere, either shift it or use leading blocks to take it clear.
- (ii) Always look out for chafe anywhere and take steps to prevent it, as it is a frequent cause of accidents.
- (iii) Remember that a fibre rope which has been set up taut while dry will shrink when subjected to rain or dew. Unless the extra strain caused by the resulting shrinkage is relieved at once it will pull the rope out of shape, and if thus repeatedly neglected the rope will eventually part.

BENDING ROPES TO HAWSERS

To Bend a Heaving Line to a Berthing Hawser.—Secure the heaving line to the bollard eye of the hawser with a long bowline. This will give the men hauling it a better grip as the eye of the hawser comes to the fairlead or bollard and will enable the line to be slid clear as the eye is placed over the bollards.

To Bend a Messenger to a Heavy Hawser.—A messenger is used instead of a heaving line to pass the heavier hawsers between ships, or ship and shore, as it is made of heavier stuff. It should be bent to the neck of the eye of the hawser with a rolling hitch, and firmly stopped to the crown of the eye. The eye of the hawser can then be hauled through a fairlead and the stop be cut, leaving the eye free for shackling on. The rolling hitch should be well secured and stopped, and the stop on the eye should be firmly secured to prevent the hitch sliding over the shoulders of the eye.

BELAYING

To Belay a Fibre Rope to a Single Bollard—Bring the rope to the bollard and belay it, as shown in the illustration. Whenever belaying to a bollard the first turn must be taken round it as low down as possible, and overlapping or riding turns should be avoided.

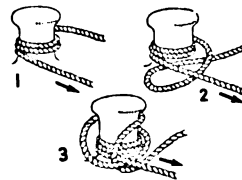


Fig 102.—Belaying a fibre rope to a single bollard

To Belay a Wire Rope to a Single Bollard.—Pass the rope round the bollard with sufficient turns to grip and then seize the end to the hauling part, as shown in the illustration.

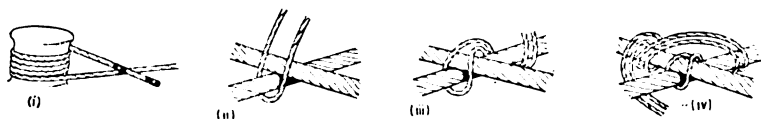


Fig. 103.—Belaying a wire rope to a single bollard

A good method of racking the end of a rope belayed to a single bollard is as follows (see Fig. 103(ii), (iii) and (iv)) :—

- (i) middle the racking underneath the rope ;
- (ii) pass both parts of the racking over the end and under the rope ;
- (iii) take a turn round the end ;
- (iv) pass the seizing under the rope, and repeat as in (ii) and (iii) above as often as required.

To finish, separate the parts of the racking, bring them up each side of the cross, and secure them with a reef knot on the top.

Reasonably stout rope of at least $\frac{1}{2}$ -inch size should be used for racking ; spunyarn is not strong enough.

To Place the Eyes of two or more Berthing Hawasers over a Single Bollard—When two or more berthing hawasers have to be secured to the same bollard the eye of the second hawser must be passed up through the eye of the

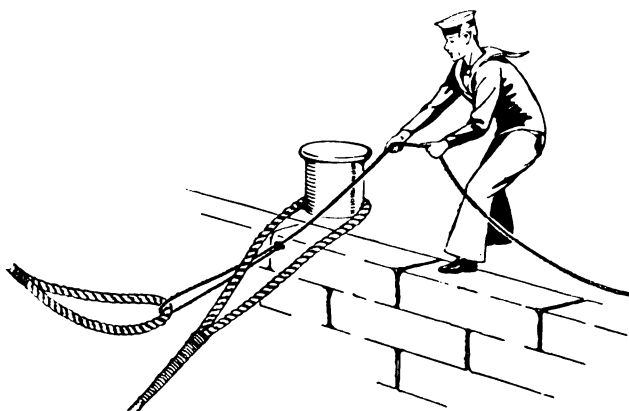


Fig. 104.—Placing the eyes of two berthing hawasers on a single bollard

first before it is placed over the bollard ; similarly, the eye of a third hawser must be passed up through the eyes of the first two ; this enables the hawasers to be cast off the bollard in any order.

To Belay a Hawser to Twin Bollards.—Lead the hawser round the bollard farthest from the source of the strain, from outboard to inboard ; then belay it with figure-of-eight turns as in Fig. 105(i).

If the hawser is to be belayed for a full due the turns can be racked as follows (see Fig. 105(ii)) :—

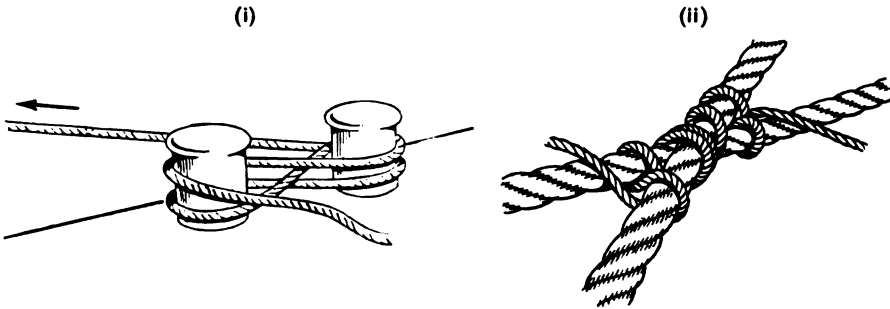


Fig. 105.—Belaying a berthing hawser to twin bollards

- (i) rack together the two upper turns only ;
- (ii) middle the racking and make an overhand knot round the cross of the two upper turns of the hawser ;
- (iii) with each part of the racking pass racking turns round both parts of the upper turns, working outwards from the cross ;
- (iv) when sufficient racking turns have been taken, knot both parts of the racking over the cross with an overhand knot ;
- (v) pass the ends in opposite directions round all the turns, haul the ends taut, and finish them off with an overhand knot on the top.

To Belay a Heavy Hawser to Twin Bollards.—When extra heavy strains are involved, as in towing operations where the load may be near the limit of strength of the bollards, it is advisable to belay the hawser as shown in the illustration ; this puts the strain on the bollard mounting in the most equable manner and obviates any tendency of the hawser to rack the bollards together. The standing end can be taken to a deck clench, as illustrated, or be belayed with figure-of-eight turns to another pair of bollards.



Fig. 106.—Belaying a towing hawser to twin bollards

HANDLING HAWSERS UNDER STRAIN

To Catch a Turn on a Single Bollard.—When a rope is under strain, catching an extra turn round a single bollard is difficult unless done correctly. Careful attention should be paid to the position of the hands and fingers to prevent them being nipped, especially if the hawser should render.



Fig. 107.—Catching a turn on a single bollard

To Catch a Turn round Twin Bollards.—Fig. 108 illustrates the method of catching turns with a hawser under strain round twin bollards. Note that the lead is first to the bollard farthest from the source of strain, and from outboard to inboard. Belaying turns of a hawser leading forward are taken right-handed on the starboard side of a ship, and left-handed on the port side.

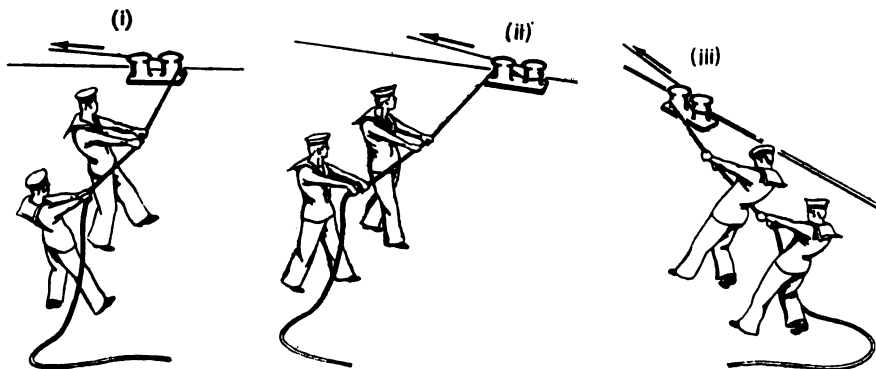
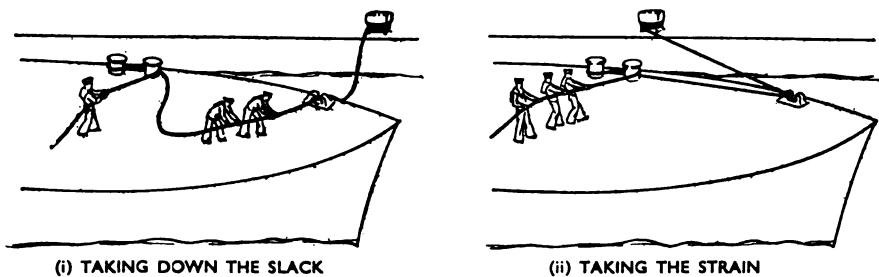


Fig. 108.—Catching a turn round twin bollards

To Handle a Heavy Rope which is alternately Slack and Under Strain.—If space permits, it is best to keep one turn on the bollards and man the rope "before all" when hauling in the slack. Note that the two men in Fig. 109 (i) are standing on the wrong side of the hawser.



(i) TAKING DOWN THE SLACK

(ii) TAKING THE STRAIN

Fig. 109.—Handling a hawser which is alternately slack and under strain

As the slack comes in, one man (or two with a very large rope) can fleet it round the bollards, and at the same time be ready to back it up and take more turns when the strain comes on.

Backing Up.—When a seaman finds that the strain on a rope is becoming more than he can hold he instinctively takes a turn round the nearest bollard, cleat, or other fixture, and then backs up the additional grip thus obtained with his own weight. If he expects a still heavier strain he takes as many additional turns round the fixture as are required to take the strain.

To Pay Out a Heavy Wire Hawser.—When paying out a heavy hawser it must be kept under control, otherwise the weight of its bight outboard may cause the hawser to take charge and run out. It should be flaked in as long fleets as the deck space permits, and the bight of each flake should be secured to an athwartships jackstay. Each bight should be eased out in turn by a light line surged round an adjacent pair of bollards, and a chain check stopper should be provided near the fairlead for use if required.

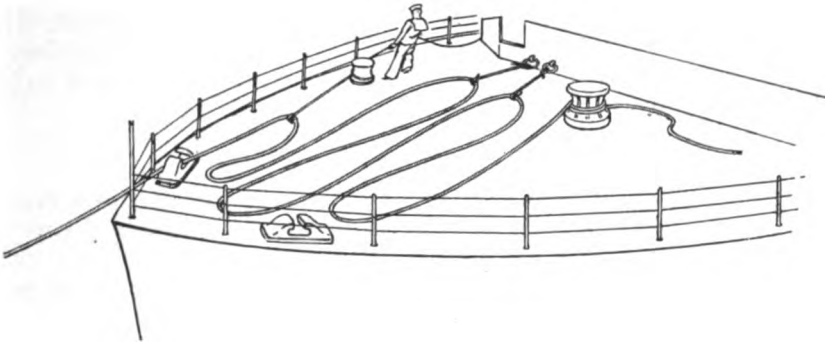


Fig. 110.—Paying out a heavy hawser

When paying out, the bight should be neither too taut nor too slack, so as to keep to a minimum the effort required to haul it in. Theoretically, the minimum effort is required when the rope dips at an angle of about 52° to the horizontal, but for practical purposes this angle can be kept to within from 35° to 70° (Fig. 111).

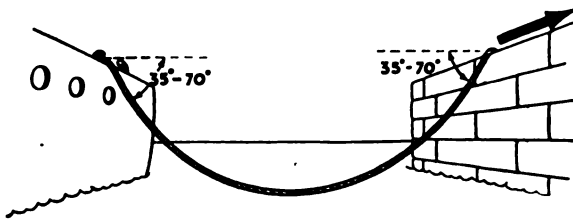


Fig. 111

Surging.—Essential rules for surging are : to surge smoothly, not jerkily, and to keep sufficient control to be able to surge with the maximum safe strain on the hawser.

A hawser with too many turns round the bollard will not render round it smoothly and may therefore part, and with too few turns the hawser may take charge and run out. It should be remembered that catching an additional turn round a bollard is easier than taking one off.

When too many men back up a hawser they are apt to get in each other's way, with the result that efficient control of the hawser is lost.

Success lies in taking a sufficient number of turns round the bollard to reduce the strain on the hauling part to manageable proportions. Generally speaking, two to three turns should suffice for surging under normal conditions, and up to three men should be sufficient for backing up. An expert man can handle a $3\frac{1}{2}$ -inch wire rope by himself and keep it under complete control when surging by catching or removing turns as required.

The number of turns for surging will always depend upon the strain on the rope, the size of the rope and bollards and the resulting friction between them, and the number of men backing up on the hauling part. Under normal conditions a practical guide to the number of turns required is that each complete turn round a bollard reduces the strain required on the hauling part by one

quarter ; allowing a man a backing-up pull of 70 lb. he will therefore be able to hold :—

one-eighth of a ton with one turn.
 half a ton with two turns,
 two tons with three turns, and
 eight tons with four turns.

Seventy pounds is a very conservative estimate of the effort each man can apply ; three men, by backing up, could easily part a 2-inch F.S.W. rope with three turns round a bollard, or a $3\frac{1}{2}$ -inch F.S.W. rope with four turns ; similarly, a 4-inch F.S.W. rope with five turns around a bollard could easily be parted when backed up by only one man.

Applying this rule to surging, if three turns are taken around a bollard with a 3-inch F.S.W. rope and each of three men exerts a pull equal to half his weight, the rope should surge under a strain of 6 tons, which is about the limit of the working load of the rope.

It is emphasised that this rough rule applies only with normal conditions of friction between the rope and the bollard. With a greasy or wet rope, or a polished bollard, more turns or more men are required. Conversely, a rusty or dry rope, or a painted or rusty bollard, may increase the frictional grip of each turn by as much as four or even eight times.

Reeling a Hawser under Strain.—A wire hawser which is reeled under strain on a winch (as when hauling in a target at high speed) will tend to unlay and thus develop a considerable number of turns which will be stored in the hawser. These turns will tend to snarl up the hawser when it is next unreeling unless a fair degree of tension is kept on it throughout the process of unreeling. The remedy lies in reducing the strain in the hawser as much as possible while reeling in.

Parting of Hawsers.—When a wire hawser is about to part it may emit a humming noise, or a high-pitched whine, as it reaches the limit of its strength. If the overload has been applied steadily the individual wires usually part first, then the strands will part one by one and the two ends of the parted hawser will usually “ lie dead ”. If, however, the overload has been applied suddenly there is a chance that all the strands will part simultaneously, in which case there is a possibility of the two ends springing back on their standing parts with a consequent danger to anyone standing in the vicinity. If a berthing hawser parts it will probably part at the fairlead, or at the shoulder of the splice of its bollard eye, and it is therefore inadvisable for anyone to stand between the fairlead and the bollards when working hawsers.

STOPPERS AND STOPPERING

To belay a rope which is under strain the strain must be taken temporarily with a stopper. The type of stopper used depends on whether it is to hold a fibre or a wire rope, and on the strain it is required to take.

A *Cordage Stopper* is used for fibre hawsers only, and consists of a length of cordage made fast to a ringbolt or other fixture. The stopper is laid alongside the hawser with its tail pointing towards the source of strain ; the tail is half-hitched round the hawser *against* the lay, and then dogged round the hawser *with* the lay ; the end is then held by hand or stopped to the hawser.

A *Chain Stopper* is used for wire hawsers only. It is similar to a cordage stopper except that it consists of a length of chain. The half hitch is put on *with* the lay of the hawser, and the tail is dogged round *against* the lay.

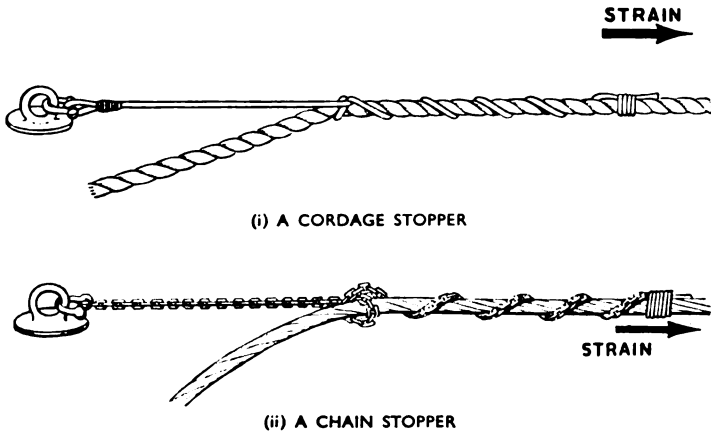


Fig. 112.—Types of rope stoppers

Fig. 113 shows an example of the use of a cordage or chain stopper. The hawser, which has been hove in by the capstan, is under strain, and it is desired to belay it to a pair of bollards.

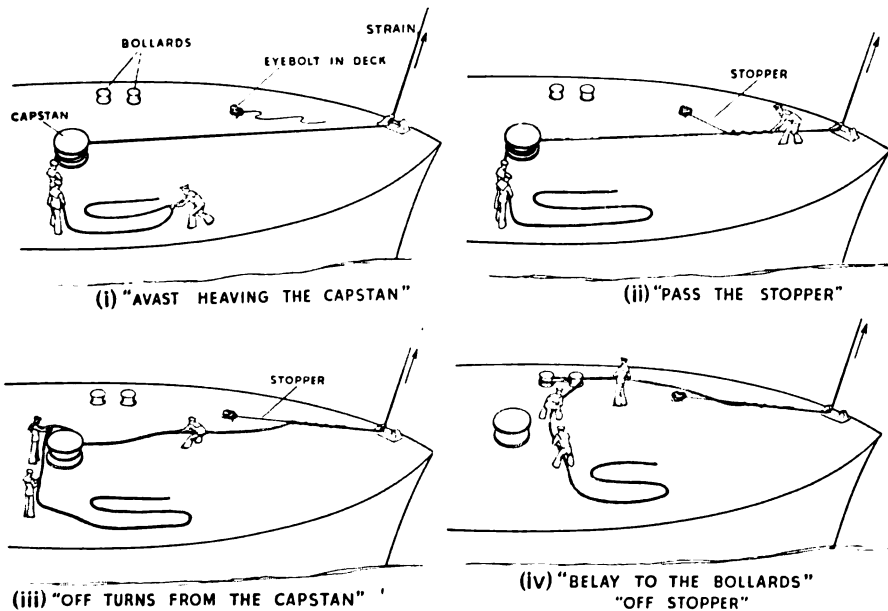


Fig. 113.—Use of a stopper when berthing ship

The stopper should be passed as close to the fairlead as possible, and as nearly as possible in the line between the fairlead and bollards, to avoid loss of slack as the hawser is transferred from the capstan to the bollards.

A *Chain Check Stopper* is entirely different in nature and purpose from those already described, and is used to control the speed at which a wire hawser is being paid out.

It is rove so that a pull on the tackle will jam the hawser against the eyebolt, thus operating as a brake and bringing it to rest.

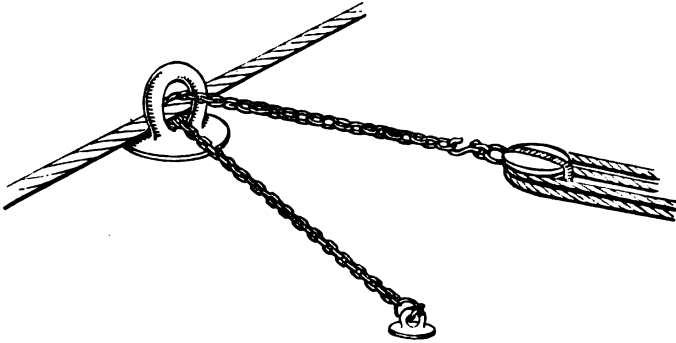


Fig. 114.—A chain check stopper

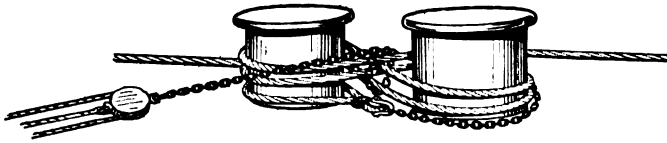


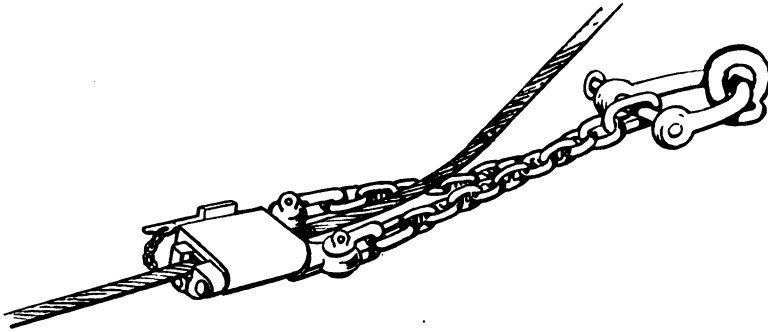
Fig. 115.—Racking a large hawser for surging round bollards

If a heavy hawser is to be surged under strain it may be best to take two figure-of-eight turns with it round a pair of bollards, and rack it with a chain stopper by taking a round turn with it round the cross of the turns of the hawser, as shown in Fig. 115. The standing end of the stopper is shackled to a bollard stop on one of the bollards and the hauling end is secured to a tackle.

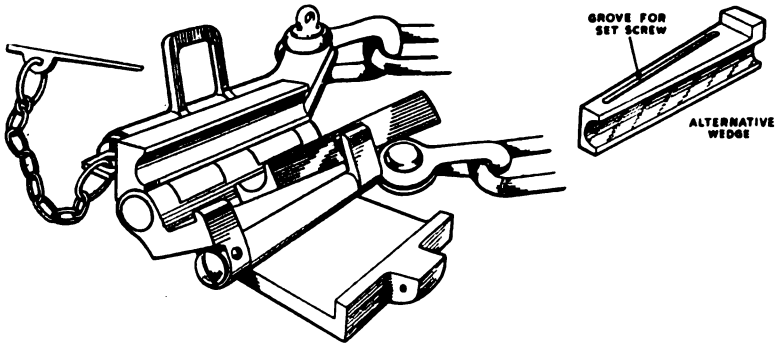
A *Carpenter's Stopper* is also used only on wire rope, and is for temporarily holding a rope which is under strain. It is a mechanical device consisting of a metal block made in the form of a thick-sided box, of which both ends are open and the top hinged to form a lid. The body of the box is made in two longitudinal halves, which are joined together at the bottom with a hinge so that it can be opened out for inserting the wire rope.

Internally, one side of the box is parallel with, and the other inclined to, the lead of the rope, thus making the opening at one end wider than at the other. A groove, shaped to take the lay of the rope, is cut lengthways in the parallel side; and a wedge-piece, the inner side of which is similarly grooved to grip the opposite side of the rope, slides in against the inclined side. When the rope is inserted the lid is shut and clamped and the wedge-piece then pushed home as far as it will go, so that immediately any pull comes on the rope the wedge-piece is drawn hard into the block and jams the rope.

The stopper is attached by a chain bridle to a triangular link which is shackled to an eyebolt or other suitable fixture.



(i) THE STOPPER ON A ROPE



(ii) COMPONENT PARTS OF THE STOPPER
Fig. 116.—A Carpenter's stopper

Each stopper is supplied with two sizes of wedge-piece so that it can be used for two different sizes of rope ; a 2-inch stopper, for example, can also be used for a 2½-inch rope. The wedge-piece can be withdrawn and changed after slackening the set-screw securing it, which is inserted in the underside of the block.

Berthing Hawser

Fig. 117 shows how berthing hawsers are used to secure a ship alongside a wall or a jetty.

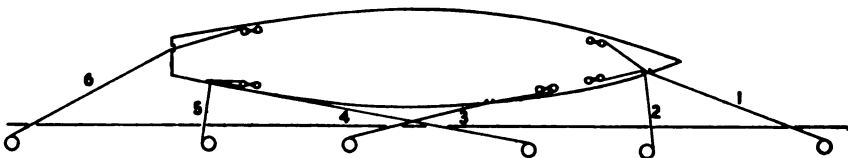


Fig. 117.—Berthing hawsers

BREAST ROPES

It will be seen that she has two "breast ropes", marked 2 and 5, which are known respectively as the fore and after breast ropes. They are used to breast

the ship bodily towards the jetty when coming alongside, and when belayed they limit her distance from the jetty. They are also used to hold a small ship upright against a jetty when she is resting on the bottom.

SPRINGS

The hawsers marked 3 and 4 are known respectively as the "fore spring" and the "after spring". Any spring which leads *forward* is known as a "back spring", and any which leads *aft* is known as a "head spring". When a ship is secured alongside, the head and back springs prevent her from "surging" ahead or astern at her berth, and together they assist the breast ropes to keep her close alongside.

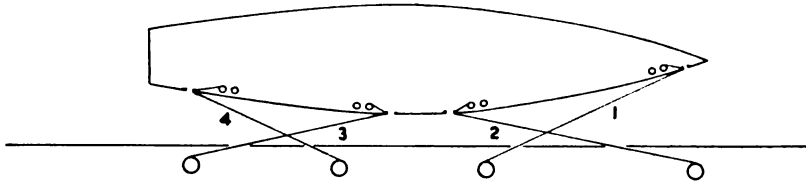


Fig. 118.—Springs

For a large ship, or a ship berthed near a busy fairway where she is more liable to surge, or for any ship berthed in heavy weather, the springs may be duplicated as shown in Fig. 118. These springs are then named as follows :—

- 1— fore head spring ;
- 2— fore back spring ;
- 3— after head spring ;
- 4— after back spring.

HEAD AND STERN ROPES

The hawsers marked 1 and 6 are known respectively as the "head rope" and the "stern rope". They assist the springs in preventing the ship from surging, and they are also used to regulate the position of the ship along the jetty, especially when she is going alongside.

SECURING AND CASTING OFF

When a ship goes alongside, the berthing hawsers required for working the ship to her berth will usually be a head rope, one head and one back spring, and perhaps two breast ropes. The order in which they will go out depends upon the circumstances, but each berthing hawser required for working the ship should be ready flaked for running, with its bollard eye led out through the correct fairlead and stopped outboard to the top guard-rail, where it will be ready for a heaving line to be bent to it by the time the ship is within heaving distance of the jetty. If the capstans are going to be used, it will probably be for breasting the ship in with the breast ropes, or for adjusting her distance along the jetty with the head and stern ropes.

When a ship is secured alongside in a tide-way, particular attention must always be paid to her berthing hawsers as she rises and falls with the tide, and, whenever possible, the hawsers should be so belayed that each can be tended without disturbing another.

A berthing hawser may be "doubled up" by leading it from the ship round a shore bollard and back to the ship, and making fast both ends inboard.

Such hawsers are usually "singled up" well before the ship is due to unberth so as not to delay the final stage of unberthing. A berthing hawser may also be rove doubled when there is nobody on shore to cast it off when the ship unberths.

When a ship leaves a jetty the number of berthing hawsers required will depend upon the circumstances, but normally the head and stern ropes and one head and one back spring should suffice. The head and stern ropes may have to be brought to the capstans and the springs may have to be surged.

When a ship is being warped by her berthing hawsers each hawser should be tended, and the hands tending them should be prepared to back up, surge, take down the slack, bring to the capstan, or belay them, as required. Smartness in handling hawsers is essential.

Rat-guards.—When a ship is berthed alongside, rat-guards should be clamped on each berthing hawser as soon as the ship is secured. Rat-guards are circular metal discs about 2 feet in diameter, and they prevent rats from climbing inboard along the berthing hawsers.

Propeller Boards.—These are boards on which is painted the word "propeller", and they are displayed in ships whose propellers project outboard from the side of the hull. They are shipped in brackets, facing outboard at upper deck level, over each propeller. They indicate to harbour craft the positions of the propellers and they should be shipped whenever the ship docks or berths alongside, or whenever she is manoeuvred by tugs, or when other vessels are berthed alongside.

Fitting, Supply, and Maintenance of Hawsers

LENGTH AND FITTING

In the Royal Navy fibre hawsers are supplied in coils of 120 fathoms and fitted with a point and becket at each end. With the exception of coir rope they are intended for use either as hawsers, messengers, or as the falls of heavy purchases such as the deck-tackle which is used for weighing the anchors by hand. The point facilitates reeving through the blocks of purchases, and the becket enables the hawser to be tailed with a light line for ease in handling, as when reeving the hawser through an over-head block for example. It is the practice to splice a bollard eye into one end of a fibre hawser if it is to be used as a berthing hawser.

Wire hawsers are supplied in lengths of 150 fathoms, fitted at each end with a hawser eye. A bollard strop made from wire rope of a smaller size is supplied for each wire hawser to enable its ends to be secured to bollards. An anchor shackle of the same strength as the hawser is supplied with each hawser for joining it to another hawser or to its bollard strop. Only anchor shackles whose bolts are secured with a pin and pellet are used for connecting hawsers; screw, or pin and forelock shackles are not suitable for this purpose. Anchor shackles are provided because they are long enough in the clear to take the two hawser eyes, the ordinary joining shackle not being long enough for this purpose.

The size in inches of the bollard strop and anchor shackle supplied for each size of wire hawser is given in the following table :—

<i>Hawser</i>	<i>Bollard Strop</i>	<i>Anchor Shackle</i>
6½	5	2½
6	5	2
5½	4½	1¾
5	4½	1½
4½	3½	1¾
4	3½	1¼
3½	3½	1½
3	2½	1
2½	2½	¾

BERTHING HAWSERS

These are usually of flexible, or extra special flexible, steel wire rope, but can be of fibre rope in small ships. They are supplied in coils of from 40 to 70 fathoms and are fitted with a bollard eye at each end. Six or seven berthing hawsers are usually supplied to each ship, the sizes of those supplied varying with her type and class.

SPRING AND HURRICANE HAWSERS

These are of manila or sisal, and E.S.F.S.W. rope, and are made up in two ways as shown in Fig. 119. They are used as berthing hawsers in heavy weather on account of their extra elasticity, and are also very suitable as emergency towing hawsers.

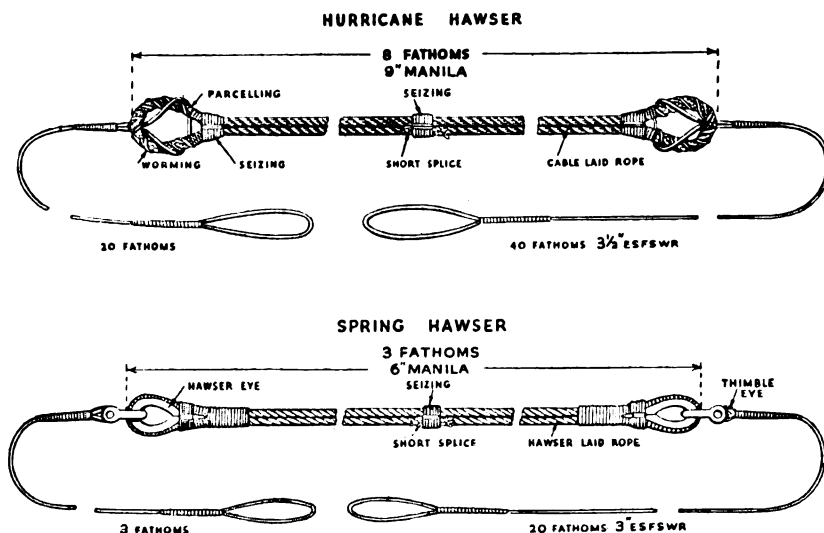


Fig. 119

SHIPS' OUTFITS

The number and types of hawsers supplied to a ship vary with her class and size. Some or all of the hawsers given in the following table may be provided in a large cruiser :—

NO.	SIZE AND TYPE	LENGTH IN FATHOMS	SPECIAL USES
1	6½-in. F.S.W.R.	150	Cable for laying out bower anchor. Main towing hawser.
1	5½-in. F.S.W.R.	150	Cable for stream anchor. Secondary towing hawser.
1	4½-in. F.S.W.R.	150	Cable spring for pointing ship. Cable for stream or large kedge anchors.
2	3½-in. F.S.W.R.	150	Cables for large and small kedge anchors.
1	2½-in. F.S.W.R.	150	Cable for small kedge anchor. Towing hawser for small targets.
3	4½-in. E.S.F.S.W.R.	70	Head and stern ropes for berthing.
4	4½-in. E.S.F.S.W.R.	50	Breasts and springs for berthing.
6	10-in. sisal and 3½-in. E.S.F.S.W.R.	68	Foul weather berthing hawsers. Short or emergency towing hawsers for light tows.
1	8-in. manila or sisal	120	Messenger for passing 6½-in. wire hawser.
1	6-in. manila or sisal	120	Messenger for passing 5½-in. wire hawser. Fall for deck tackle.
1	6-in. coir	120	{ Messengers for passing the 6½-in. and 5½-in. wire hawsers with their respective fibre hawsers.
1	5-in. coir	120	

STOWAGE

Fibre hawsers are usually stowed on simple reels, fitted overhead on a bulk-head or to a deck-head. The drum and flanges of a hawser reel should be of skeleton framework construction to allow the air to circulate round the hawser and thus keep it dry. Both ends of the hawser should be stopped by their beackets to the framework of the flange. The reel should be secured by a lanyard, fitted on the flange, to prevent it rotating when the hawser is stowed.

Wire hawsers are stowed on heavy reels bolted to the deck ; each reel is fitted with a pawl and ratchet, a hand band-brake, and removable hand cranks (see Fig. 120(i)).

For reeling up (see Fig. 120(ii), (iii) and (iv)), the eye on the first end of a large wire hawser is tailed with a short length of line. The eye should be inserted into the slot provided for it in the drum, and then be hauled inside

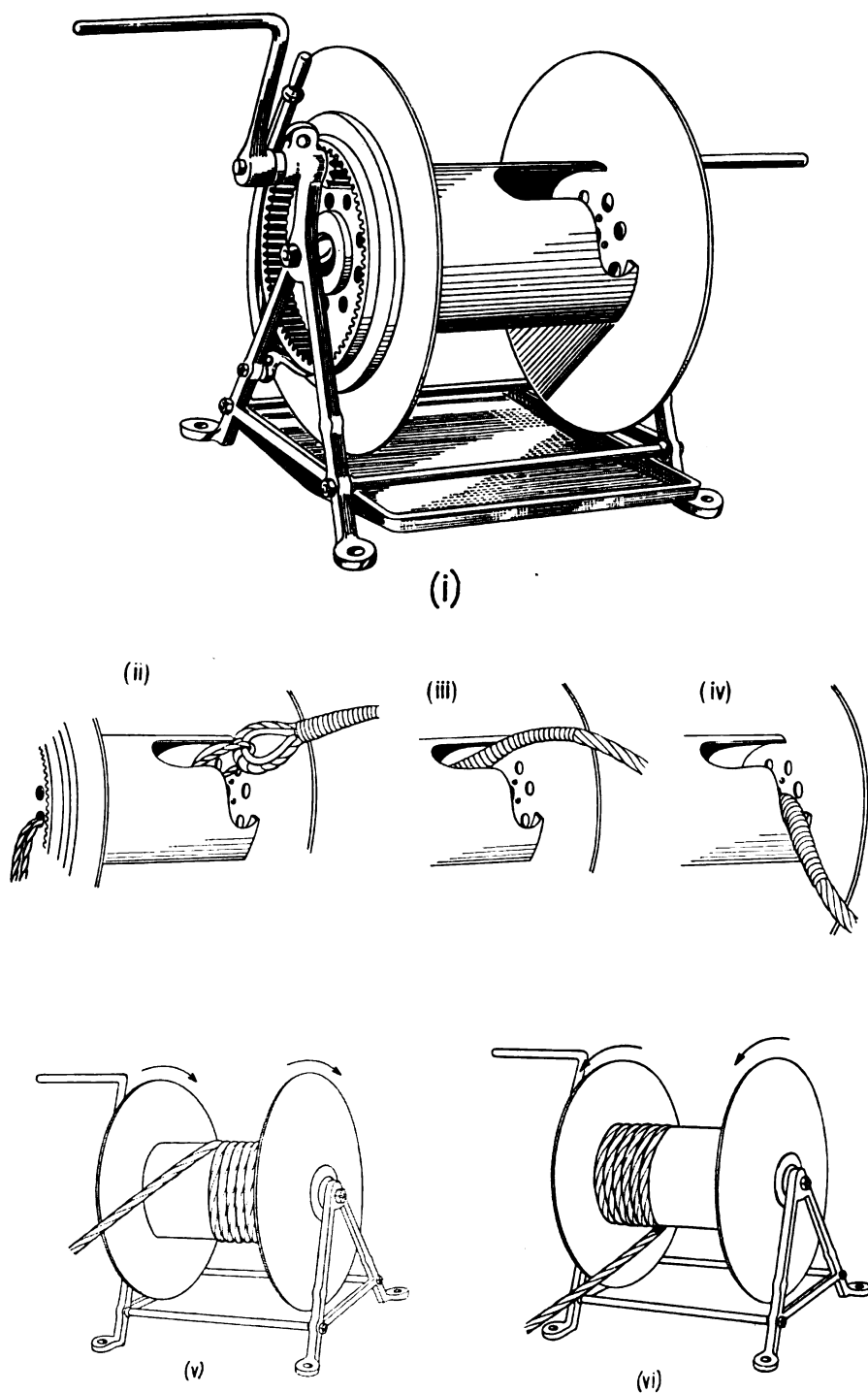


Fig. 120.—Stowage of wire hawsers on reels

as far as it will go and secured by this line ; the neck of the eye is persuaded into the other part of the slot by a few light taps with a maul. The reel is then rotated while a steady strain is kept on the hawser and the turns are packed close with the maul. To obtain a neat stow it is most important that the first layer of turns should lie correctly, and this is best achieved by reeling the hawsers on the drum right-handed ; if the first end is secured on the right of the reel, the hawser should therefore be fed on from above and the reel be rotated as shown in Fig. 120(v). Similarly, if the end is secured on the left of the reel, the rope should be fed on from below, as in Fig. 120(vi).

The shape of the slot in the drum for the first end of the hawser automatically ensures conformity to the foregoing rules.

As the reel is rotated, layers will be formed alternately into right and left-handed coils ; if left thus reeled for a long time these turns may, in some degree, become set in the hawser.

MAINTENANCE OF HAWSERS

Wire ropes intended for use on board ships are tinned or galvanised as a protection against rust. The smaller ropes are supplied in full length coils, wrapped in sacking. They should be stored, in a dry and well-ventilated place, on battens to keep them clear of the deck and to allow the air to circulate freely around them.

Hawsers should be stowed on reels under a canvas cover whenever possible. While being reeled or otherwise stowed, the surface of a wire hawser should be washed with fresh water to free it of salt, dried with cloths, and then lightly smeared with an acid-free lubricant applied with a cloth pad. The best lubricants are boiled linseed oil, petroleum jelly, tallow, or the proprietary brands supplied by the rope manufacturers. Care should be taken not to apply too much lubricant, otherwise the rope will be difficult to handle and will not provide sufficient friction to grip when brought to bollards or capstans.

Any broken wires protruding from the hawsers should be broken off as close as possible to the strands ; and, if any portion of the hawser has been flattened, it should be carefully " rounded up " by tapping it with a hammer or a maul.

Wire rope which has been allowed to become rusty should be well scrubbed with a wire brush to remove the rust, and then lubricated. Such rope, however, should be used with caution, as the rust shows that the galvanised protection has worn off and that the consequent corrosion may have considerably weakened the rope.

Wire hawsers not in constant use should be unreeled periodically, flaked down on tarpaulins, and oiled overall with wads.

Wire hawsers are surveyed every six months, at the same time as the anchors and cables and rigging screws.

GENERAL REMARKS ON CORDAGE

Types and Characteristics

Cordage is made from various kinds of vegetable fibre. The fibre selected depends upon the use for which the cordage is intended, because each kind makes rope which may differ in : strength, weight, flexibility, hardness or resistance to wear, elasticity, resistance to weather, or behaviour when wet.

When made of sisal or hemp, the resistance of rope to weather is increased by treating its constituent yarns with Stockholm tar when the rope is being

made. This process, however, weakens the rope, increases its weight, and is not suitable for rope made of manila, and it is now (1950) obsolescent. It will shortly be superseded by a new process called "rot-proofing", which was evolved by British chemists and ropemakers during the Second World War when Stockholm tar was difficult to obtain. Rot-proofing consists of treating the fibres of the rope with a special solution during the first stage of ropemaking when the fibres are being combed into ribbons, so that each fibre becomes impregnated with the solution. Rot-proofing is a very much better process than "tarring", because it is suitable for manila as well as sisal or hemp, it does not weaken the rope or increase its weight, it makes the rope water-tight and so increases its resistance to weather, mildew and rot, and the process is cheaper. Rot-proofing also has the advantage of making the rope water-tight to the extent that when wet it absorbs hardly any water and so is nearly as light and as easily handled as when dry.

The tables of sizes, weights and breaking stresses of cordage given on p.p 154 to 163, inclusive, are for natural rope (manila, sisal, hemp and coir), tarred rope (sisal and hemp), and rot-proofed rope (manila, sisal and hemp), and care should be taken when using these tables to ensure that the correct table is used.

To assist in distinguishing the different types of cordage a coloured thread, known as a "rogue's yarn", is woven into the strands of each type of rope supplied by the Admiralty Ropery. A coloured yarn is also used in commercially manufactured rope to indicate the fibre it is made of and its quality.

MANILA ROPE

This rope is made of fibre from the leaf of the plantain or wild banana tree, which is grown extensively in the Philippine Islands; when new and untreated it is deep golden brown in colour. It is flexible and stands up well to wear and weather, and so is very suitable for slings, falls, berthing hawsers and tow-ropes.

Manila hawser-laid rope is supplied to the Royal Navy in coils of 120 fathoms, and is marked with one *red* rogue's yarn in *each of two* strands. Cable-laid rope is supplied in coils of 100 fathoms.

Commercially made manila over 2 inches in circumference and complying with the specification of the British Standards Institute may be marked as follows:—

- Grade I, "Special", one *black* yarn in *three* strands;
- Grade II, "Standard", one *black* yarn in *two* strands;
- Grade III, "Merchant", one *black* yarn in *one* strand.

SISAL ROPE

This rope is made from the leaf of the agave plant, of the cactus family, which grows in Kenya and Tanganyika; new and untreated sisal is hairy and of a pale straw colour. When new it is as strong as second grade manila, but is not so flexible nor so durable and resistant to wear and weather, and it should therefore be examined frequently for signs of deterioration.

Because it is not so reliable as manila it is not used for boats' falls, or for slings or for other purposes where the parting of the rope may endanger life.

Sisal hawser-laid rope is supplied to the Royal Navy in coils of 120 fathoms, and is marked with one *yellow* rogue's yarn in *each of two* strands. Cable-laid ropes are supplied in coils of 100 fathoms.

Commercially made sisal cordage complying with the specification of the British Standards Institute, and of over 2 inches in size, may be marked with one *red* yarn in *each of two* strands.

Tarred Sisal is made from sisal yarns treated with Archangel tar, and is dark brown in colour. It is not so strong as natural sisal and is heavier, but it weathers better.

HEMP ROPE

This rope is obtained from the skin of a nettle-like plant grown in many parts of the world, notably Italy, Russia and other parts of Europe, also China, the U.S.A., New Zealand, St. Helena and India.

Hemp is very much softer than the other fibres. Its quality varies greatly with the soil in which it is grown, and for purposes of Admiralty specification it is divided into four grades, which are tabulated in order of quality as follows :—

Italian,
European,
New Zealand and St. Helena, and
Indian.

Italian hemp is the strongest fibre used in ropemaking, and Indian hemp is not suitable for reliable cordage. European hemp comes from many different localities, but on the average is of good quality. Hemp from the U.S.A. is about equal to European hemp, but is not used by the Admiralty. New Zealand and St. Helena hems are not true hems like Italian, but produce hard fibres similar to those of sisal.

New "white" (*i.e.* untarred) hemp cordage is hard, smooth, pale straw in colour and of a lighter shade than manila but darker than sisal. It is marked with a *red* rogue's yarn in *each* strand.

Hemp is heavier than manila, and the best quality is stronger. Its wearing qualities are about the same as those of manila, but it is far more flexible.

It is now (1948) used in the Royal Navy only for small lines and small stuff ; before the difficulties in supply caused by the Second World War (1939–1945) it was used for boats' falls, tackles, ammunition whips, and slings.

Tarred Hemp is made from hemp yarn treated with Archangel tar, and is dark brown in colour. Although heavier than white hemp it is not so strong, but weathers better.

COIR

This rope is made from the fibres in the husks of coconuts grown in Ceylon. It is very hairy, coconut brown in colour, and is often called "grass line", and sometimes "bass rope".

A coir rope is the weakest of all cordage, but has the advantage of being so light that it floats on water. It is flexible and very springy, but soon rots if stowed away wet, and does not stand up well to chafe or weather. It cannot be tarred or rot-proofed because these processes weaken it considerably.

Coir rope is half the weight and one-fifth the strength of manila, or sisal of equal size.

Coir cordage is supplied to the Royal Navy in coils of 120 fathoms, and is marked with one *yellow* rogue's yarn in *one* strand.

NYLON ROPE

Nylon is an artificial fibre produced by carefully controlled chemical processes which makes it particularly valuable as a material for cordage. It is much superior in most respects to cordage made from vegetable fibres, but

because it is much more expensive than either vegetable fibre or wire rope it is only used where superior performance or greater durability justify the extra cost.

The rope is "silky" in appearance and texture, and its fibres, unlike those of other cordage, are continuous in length throughout the rope and are of uniform thickness and tensile strength. Nylon rope is thus more consistent in weight and strength than other types of cordage. The fibres (or filaments) have high tensile and sheer strength and are very elastic; these properties make nylon rope twice as strong as cordage made from vegetable fibres and much more resistant to suddenly applied and frequently repeated loads. It is therefore particularly suitable for tow-ropes and berthing hawsers.

Nylon is also more durable and more flexible than other types of cordage, is unaffected by damp, mildew, or freezing, and does not burn readily. When wet it does not swell or lose its flexibility, but wet or dry it is more slippery to handle than other types of cordage. Size for size, nylon ropes are slightly lighter than those made of hemp, manila or sisal.

When under load nylon stretches more than other cordage, with a consequent reduction in diameter, and for this reason knots may tend to slip unless securely tied. For the same reason a short splice or an eye splice should be made with five tucks with the ends "dogged", and care should be taken to maintain the lay of the strands; if the splice is tapered, the taper should be varnished and then parcelled with adhesive tape.

Special Kinds of Rope

Apart from hawser-laid and cable-laid ropes which are described in Volume I of this manual, and "small stuff" which is described in the next paragraph, the following special kinds of rope are used in the Royal Navy and at sea generally.

Shroud-laid Rope is made from rot-proofed sisal or manila, in sizes from $1\frac{1}{2}$ inches to 12 inches. It consists of four strands laid up round a fibre heart, and though weaker than hawser-laid rope it does not stretch so much. It is used for shrouds and stays of small craft and is supplied in coils of 113 fathoms.

Boltrope is made from rot-proofed sisal or hemp, in sizes from half an inch to six inches. Boltrope is soft laid, is supplied in coils of 120 fathoms, and is used for edging sails and awnings. Weights and breaking stresses can be taken as being the same as those of cordage of similar size and normal lay.

Hammock Lashing is also made from sisal. It is laid up left-handed because when used for lashing up with a marline hitch it is less likely to unlay than a right-handed rope. It is supplied in coils of 120 fathoms.

Stage Lashing is made of rot-proofed sisal, or European hemp, and Italian hemp toppings are also sometimes used. It is soft-laid, supplied in coils of 125 fathoms, and used for securing staging *which has already been slung by other means*.

Although, according to its specification, stage lashing is equal in strength to normal European hemp rope, it is not reliable cordage and must not be used for running gear, hoisting, or slinging.

Log Line.—The construction of patent log line is quite different from that of ordinary cordage. The line is made up of a number of white hemp yarns plaited together and is designed to transmit the drive of the rotating log. It is also used for the stray line of a Kelvin sounding-machine.

Log line is very flexible, will not kink, is of distinctive appearance, and can be spliced only by the manufacturers. It is very expensive and should not be used for purposes other than those specified above.

Signal Halyard is made of rot-proofed sisal and is soft-laid. From one-quarter to one-third of the yarns in each strand are reverse-spun (left-handed) which gives increased flexibility. It is supplied in coils of 122 fathoms.

Hand Lead Line is also made of rot-proofed sisal and is soft-laid in order to reduce to a minimum the possibility of its stretching. It is supplied in coils of 113 fathoms.

Junk consists of condemned cordage of four-inch size and above.

Rounding is condemned cordage of under four inches in size. Junk and rounding are supplied for lashings and other securings where good rope is not necessary.

Oakum is made from tow, or from condemned cordage picked to pieces. It is used for caulking seams in wooden decks and in the sides of wood-built vessels and boats.

Small Stuff

All cordage under half-an-inch in size is designated "small stuff", and can be classified as follows:—

twines,
spun yarn and houseline,
lines, and
marline and nettlestuff.

It is manufactured on the same principles as other cordage.

A twine consists of two, three, or four threads, twisted together (not laid up) left-handed. A thread is a very small yarn, spun right-handed from flax or hemp.

Spun yarn and houseline consist of a number of threads twisted together, and are similar to twine in construction, but much larger.

Lines are small ropes made of threads twisted into strands which are then laid up into the line. The smallest line is whiting line, the strands of which each consist of fine seaming twine.

Nettlestuff and marline are made of yarns laid up together.

Details of small stuff supplied to the Royal Navy, together with some additional stuff used in the Merchant Navy, are given here. Weight, breaking stress, and method of supply are shown in the table on page 163.

TWINES

Roping Twine is made from flax or Italian hemp, and is used for whipping the ends of ropes.

Seaming Twine is also made from flax or Italian hemp, and is used by the sailmaker. It varies from extra fine to extra coarse.

Seine Twine is a coarse twine made from European hemp, and is used for making nets.

SPUNYARN AND HOUSELINE

Spun yarn consists of from two to ten yarns twisted (spun) together, and may be made from any type of fibre or from yarns unlaid from any kind of old rope. The largest type likely to be encountered has only four yarns. It is

normally twisted up left-handed, but if made from yarns from a left-handed rope the spunyarn will be right-handed. It may be tarred, and is used for servings, stops, or any small work. Spunyarn is not reliable cordage and has no specified strength.

Houseline differs from small three-yarn spunyarn only in that it is made of rather more reliable material and so has a specified breaking strength. It is made from three yarns of Italian or European hemp, and is used for general purposes, but very seldom in the Royal Navy.

LINES

White Line is made of Italian hemp. It is supplied in 20-fathom lengths, and measured by weight; the classification "2½-lb. line", for example, indicates that 20 fathoms weighs 2½ lb. White line ranges from half a pound to 4 lbs. per 20-fathom length.

Fishing Lines are similar to white line, but vary in length. They are classified as albicore, cod, mackerel, and whiting line, and diminish in size in that order. Whiting line differs from the others in that it is made of fine flax seaming twine.

Hambroline can be made from Italian or European hemp. It is a small three-stranded line of normal right-hand lay, which may be tarred and usually presents a polished appearance. It is used for general purposes, but very seldom in the Royal Navy.

Roundline differs from hambroline only in that it has a left-hand lay. It is not supplied to the Royal Navy.

MARLINE AND NETTLESTUFF

Marline is made of Italian, European, New Zealand, or St. Helena hemp, and consists of two yarns laid up left-handed. It is used for marling down, small stops, and similar work. As with hammock lashing its left-hand lay makes it suitable for use with the marline hitch. It may be tarred or plain.

Nettlestuff is made of white Italian or tarred European hemp, also New Zealand or St. Helena hemp. It consists of two or three yarns, reverse spun (left-handed), and laid up together right-handed.

Manufacture of Cordage Supplied to the Service

HARD AND SOFT-LAID ROPE (Fig. 121)

Not only does the twist imparted to a rope during manufacture give it elasticity and enable its fibres to hold together by mutual friction, but it also packs the material firmly, which keeps out moisture and gives the rope a hard surface against wear and tear; twisting the fibres, yarns, and strands in opposite directions also helps to counter any tendency of the rope to unlay.

Rope which is given a hard twist in manufacture (hard-laid rope) loses in flexibility and strength but gains in elasticity and firmness. Soft-laid rope, on the other hand, is very flexible, stronger and stretches less, but is more easily damaged by chafe. Rope used for ordinary purposes is given a medium twist, between these two extremes; but for edging sails, awnings and other canvas, where flexibility and minimum stretch are the first considerations, soft-laid rope called "boltrope" is used.

The distance along the rope between any two points on the same strand is known as the "jaw" of the rope, and gives a measure of the hardness of the lay; the shorter the jaw the harder the lay. A similar measure can be obtained from the "angle of the lay", which is the angle between the line of the strands and that of the rope; in this case, the greater the angle the harder is the lay. A rope in which the lay has become slack, perhaps even showing a gap between the strands, is known as "slack-jawed" or "opened".

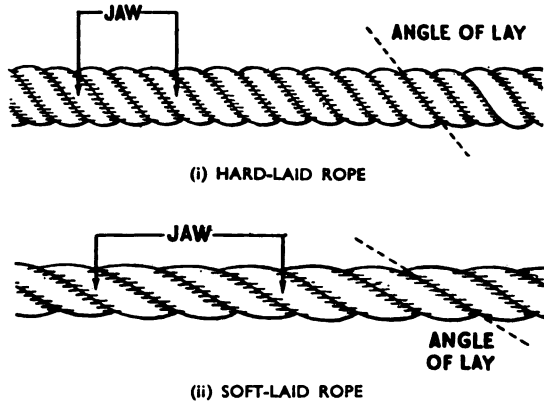


Fig. 121.—The jaw of a rope and the angle of its lay

Twisting the fibres to form the yarn is essential to enable them to hold together, but it reduces the strength of the individual fibres, and, within limits, the lighter the twist the greater is the strength of the yarn. On the other hand, bad material in a rope may be disguised by reducing the angle of lay, so that although when new it may pass the necessary test it will probably fail afterwards under normal working conditions.

With the exception of log line and some small stuff, all cordage supplied to the Royal Navy is manufactured at the Admiralty Ropery at Chatham. Log line and certain small stuff is made by commercial firms, to Admiralty specification.

Specifications, Inspection and Testing

The tables on pages 154 to 163 give the Admiralty specifications for weight and breaking stress of different types and sizes of cordage, but it must always be borne in mind that the breaking stresses given are those of *new* rope, and that these will decrease as the rope wears. A table giving details of small stuff is also included.

Standard specifications for commercially made rope are laid down by the British Standards Institute of Victoria Street, London, but cordage will not necessarily comply with them unless a certificate to that effect is given by the manufacturers. As a guide to seamen handling commercially made rope the footnote on the tables gives a general comparison between the Admiralty specification and that of the British Standards Institute. Full details concerning cordage purchased from any reputable firm can be obtained from the manufacturers, and any information regarding Standard specification can be supplied on application to the British Standards Institute.

Although any rope in good condition can be confidently expected to bear its full working load with ease, due allowance for wear must be made in assessing the strength of rope no longer new or which has been subjected to hard conditions. Before estimating the strength of such a rope it should be examined for damage, rot, and fatigue.

Signs of serious damage are most likely to be made manifest either in the strands being visibly distorted and thus bearing unequal strains, or in the rope becoming "opened".

The most usual cause for such slack-jawed or opened rope is frequent hauling by hand, which tends to unlay it near the end. Examples of opened rope are often found in the last few fathoms of boats' falls, and portions thus affected must always be cut off before the falls are turned end for end, failure to do so being frequently the cause of accidents.

Loss of strength caused by external chafe can be estimated from the proportion of damaged yarns in a strand. To assist in this estimation it should be accepted that Admiralty manila and sisal have, very approximately, $C^2 \times 3$ yarns per strand, C being the circumference of the rope. Rot can be detected by opening out the strands and examining their inner surfaces. Should the fibres be healthy and strong, all is well, but if they are powdery, discoloured, weak, or can be plucked out, it is a sign of rot.

Fatigue will most probably show itself in a reduction of the circumference of the rope below its specified size. This indicates that the rope has stretched under load and has failed to return to its normal condition. A rope which has been permanently stretched and thus reduced in size has lost a considerable proportion of its initial tensile strength and should therefore be used with great caution.

If the rope is showing no signs of damage, rot, or fatigue, it is unlikely to be much below its full strength, but some consideration must be given to its age and such of its previous history as may have weakened its fibres or lessened their grip on one another. Such weakening may have been caused by any or all of the following :—

- (i) constant stretching under heavy load ;
- (ii) stowing away wet ;
- (iii) subjection to extremes of heat and damp, as when under tropical conditions ;
- (iv) external friction round bollards and fairleads ;
- (v) internal friction due to bending round sheaves of blocks.

If short lengths of yarns can be taken which are representative of the used portion of the rope they may be tested for tensile strength and thus give an indication of the deterioration which has taken place. It is necessary, however, to know the actual or specified breaking stress of the yarns when new.

The only really reliable method by which the strength of a rope may be determined is to test a sample of the worst part of the rope to destruction.

Appearance, stretch and reduction in size are all important, but it is not possible to lay down rules which can be applied to determine the degree of deterioration in tensile strength which has occurred by these means. This has always been a question for the judgment of experienced seamen or ropemen.

Sample lengths are taken for test from a proportion of all ropes manufactured at the Admiralty Ropery. At least ten yarns from part of each sample length are removed and tested to destruction, and the rope is condemned if the average load under which the yarns break is less than that laid down in the specification.

The remaining part of the sample length itself is then tested to destruction, and should it fail to reach the specified breaking load a further sample is taken from the same rope and tested. If it fails to pass this second test the rope is rejected, but if the second test is satisfactory further samples may be taken by way of confirmation.

Ropes manufactured commercially and conforming to B.S.I. specification are tested on similar lines.

GENERAL REMARKS ON WIRE ROPE

Special Types

In addition to the wire rope whose construction has already been explained in Volume I, other types of wire rope are supplied for sea service ; the three most common of these are briefly described below.

LANG'S LAY

A rope of Lang's lay has its strands laid up together in the same direction as that in which their constituent wires were twisted (i.e. both right or left handed). This makes a rope which wears very well when used for hoisting, but it can be used only when both ends are anchored (as in ammunition hoists, lifts, and crane topping lifts), because it is liable to unlay when under stress if one end is free to rotate. Care is necessary in handling Lang's lay rope owing to its tendency to unlay, and when unreeling it a bar should be lashed across the end to counteract any tendency of the rope to twist and unlay itself.

PREFORMED ROPE

A modern development in the manufacture of wire rope is to form the individual strands into the spirals they will assume in the finished rope, before the strands are laid into the rope. This process is known as "preforming", and results in each strand lying in its correct position in the completed rope without any tendency to spring out of place should the rope break or be cut. A preformed wire rope which parts will therefore usually lie dead.

FIBRE AND WIRE ROPE

This is a rope of composite construction consisting of a mixture of fibre yarns and steel wires. This mixture results in a compromise between the strength of wire rope and the flexibility of cordage, but it must be remembered that, as the fibre is a structural part of the rope, damage to it will affect the strength of the rope. This rope is not supplied in the Royal Navy.

Terminals

Besides the thimble, hawser, and soft eyes, four other kinds of terminals are used for the ends of wire rope and these are described below.

The Bordeaux Connection (Fig. 122(i)) affords a simple means of attaching wire rope to a length of chain where both have to pass over a sheave, as in the whip of a crane used with a grab, for example.

The connection consists of a special pear-shaped thimble, which has a recess cut longitudinally round it to take the spliced eye of the rope, and a link attached to it in a recess in its head to take the end of the chain. The diameter of the thimble should be equal to the outside width of the attached link.

Sheaves over which Bordeaux connections are worked must be at least 50 per cent. greater in diameter than that given on page 147, and the radius of their grooves must be slightly greater than half the diameter of the thimble.

Sockets (Fig. 122(ii)) of various kinds are used extensively in commercial engineering; in ships they are used on aircraft arrester wires, shrouds, and certain other fittings.

When socketting a rope the wires at one end are fluffed out like a shaving brush so as to fill the hollow conical head of the fitting; the ends of the wires are then hooked over towards the centre, and molten metal is poured in to make the whole head solid. This highly skilled job is normally carried out by dockyard coppersmiths and riggers.

A well made socket terminal is as strong as the rope, but the rope itself tends to be weakened near the socket by the heating involved in the process.

Swaged Terminals (Fig. 122(iii)) are a modern alternative to sockets and are used in the Royal Navy on some catapult wires. They have the advantage of being able to be made very compact so that they can easily be rove through small apertures.

The end of the wire rope is inserted into the terminal and both are placed in a special swaging machine in which the terminal is hammered on to the wire. This process is carried out cold, and thus the temper of the wire is not affected as it is with sockets.

Shoe Links, commonly called "tulips" (Fig. 122(iv)), are used in the Royal Navy, generally on wire guardrails, but they are not often met with elsewhere. Although amply strong for guardrails they are much weaker than the wire rope.

Tulips are usually fitted by dockyard shipwrights, who insert the whipped end of the guardrail into the tulip, make three holes in the rope coincident with those in the tulip with a small spike, and then rivet the rope in place with three copper nails driven through in alternate directions.

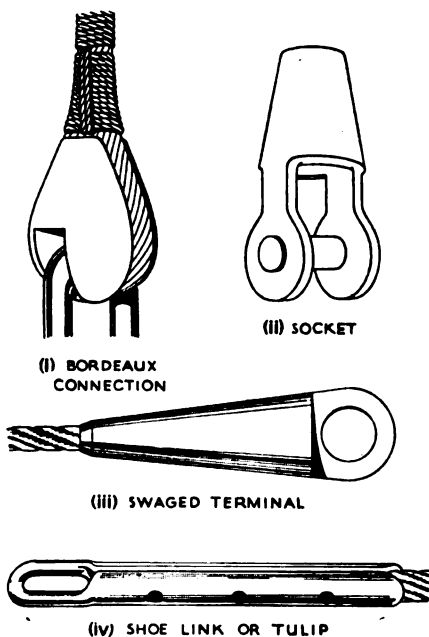


Fig. 122.—Terminals for wire rope

Flexibility

Flexibility is introduced into a wire rope in two ways:—

- by building the strands around a fibre heart, and building the wires in each strand round a fibre core;
- by building the strands round a fibre heart, and by increasing the number of wires in each strand while reducing their individual thicknesses.

With flexible steel wire rope which has a fibre heart and fibre cores to its strands it will therefore appear at first sight that, with a given size of rope,

the greater the number of wires in a strand the more flexible will be the rope. This is not so, however, because the flexibility depends upon the method of construction.

In a 6×12 F.S.W.R. there is only one layer of wires round the core of individual strands, and the size of the fibre heart and cores are relatively large in comparison with the size of the rope, which makes this type of rope very flexible. In a 6×24 F.S.W.R., however, the wires in each strand are twisted in two layers round the fibre core, the size of which is relatively small, and the rope is therefore less flexible but stronger. Nevertheless it can be said that, for a given size of rope in which the strands are built up of two or more layers of wires, the greater the number of wires in each strand the greater is the rope's flexibility.

In extra special flexible steel wire rope the cores of the strands are of wire and there may be two, three, or even four layers of wires in each strand, depending upon its size and construction. This type of rope is considerably stronger than F.S.W.R., but is not necessarily more flexible unless there is an exceptionally large number of wires in each strand. (In this respect it should be noted that the term "extra special" refers to the quality of steel of which the wires are made, rather than to the flexibility of the rope.)

The table below gives details of the construction, and compares the flexibilities, of different types of six-stranded wire rope; it also indicates the minimum diameter of sheave acceptable for each type when rove through a block.

TYPE	CONSTRUCTION OF ROPE	CONSTRUCTION OF STRANDS	HEART OF ROPE	CORE OF STRANDS	DEGREE OF FLEXIBILITY	MINIMUM DIAMETER OF SHEAVE	BREAKING STRESS (in tons)
ESFSWR	6×61	24/18/12/6/1	Hemp	Wire	Extra flexible	$C \times 5.5$	$C^2 \times 3.7$
ESFSWR	6×37	18/12/6/1	Hemp	Wire	Very flexible	$C \times 6$	$C^2 \times 3.6$
FSWR	6×12	12/Jute	Hemp	Jute			$C^2 \times 2.1$
FSWR	6×30	18/12/Jute	Hemp	Jute	Flexible	$C \times 6.5$	$C^2 \times 2.7$
ESFSWR	6×24	15/9/Jute	Jute	Jute	{Less flexible than 6×30 }	$C \times 7$	$C^2 \times 3.6$
FSWR	6×24	15/9/Jute	Jute	Jute			$C^2 \times 2.7$
ESFSWR	6×19	12/6/1	Jute	Wire	{Less flexible than 6×24 }	$C \times 7.5$	$C^2 \times 3.6$
SWR	6×19	12/6/1	Hemp	Wire			$C^2 \times 2.8$
SWR	6×7	6/1	Hemp	Jute	Least flexible	Not applicable	$C^2 \times 2.9$

Factor of Safety

To determine the size of rope to be used for any working load, a factor of safety is laid down for different conditions of working, the following formula being employed:—

Factor of Safety = Breaking Strength of rope $\div$ Working Load, or,

Breaking Strength of rope = Factor of Safety $\times$ Working Load.

Having thus found the required breaking stress the size of the rope can be ascertained from the relevant tables of breaking stresses.

The following factors of safety are used generally in the Royal Navy :—

- lifts and hoists, 12 ;
- running rigging and slings, 8 ;
- other purposes, 6.

The wear on a rope when working round a sheave increases more with an increase in its speed than with an increase in its loading. In order to get greater output from a crane or derrick it is therefore better to increase the weight of each hoist, thus accepting a reduced factor of safety, than to increase the speed of working.

Sheaves for Wire Rope

Size of Sheave required for a Wire Rope Hoist.—The table on page 147 shows the diameter of sheave required for each type of six-stranded wire rope supplied to the Royal Navy.

The diameter of a sheave used for any wire rope will considerably affect the life of that rope. As the rope bends round a sheave the strands and wires furthest from the centre of curvature move apart and those nearest the centre of curvature move closer together. This results in the generation of considerable friction between these wires and strands, and the smaller the sheave the greater will be this friction. This friction also increases rapidly with the speed at which the rope is moving.

While the rope is bent round a sheave the outer wires are also subjected to a marked additional stress, and the smaller the diameter of the sheave the greater will be this stress.

For these reasons the *minimum* diameters of sheaves recommended from practical experience for various types of ropes moving at speeds not exceeding 200 ft./min. are given in the above mentioned table. For each increase in speed of 100 ft./sec. 5 per cent must be added to these figures ; this will allow of a reasonable life to the rope, but it is emphasised that its life will be greatly increased if still larger sheaves are used.

Similarly, if a smaller sheave than that recommended has to be accepted, it will shorten the life of the rope, and on no account should a sheave be used that is more than 20 per cent smaller than the one given in the table.

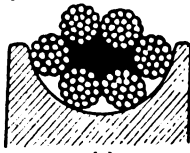
Use of the correct Sheave. The life of a rope used for hoisting can also be considerably shortened by using the wrong type of sheave. The groove in the sheave must fit and support the rope as it travels round the sheave, otherwise the life of the rope will be shortened by internal friction and external wear.

Fig. 123 (i) and (ii) show respectively :

- a sheave with too wide a groove, which results in a flattening of the rope and in considerable distortion and internal friction ; and
- a sheave with too narrow a groove, which results in the rope not being supported, the wires of the strands being subjected to considerable wear, and friction being set up between the rope and the sides of the groove.

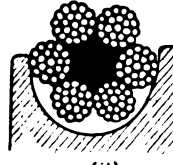
The groove of the correct sheave used should be shaped in cross section to the true arc of a circle for a distance equal to one-third of the circumference of the rope, and the radius of the groove should be between 5 and 10 per cent greater than the specified radius of the rope (see Fig. 124).

GROOVE TOO WIDE



(i)

GROOVE TOO NARROW



(ii)

Fig. 123.—Examples of incorrect sheaves for wire rope

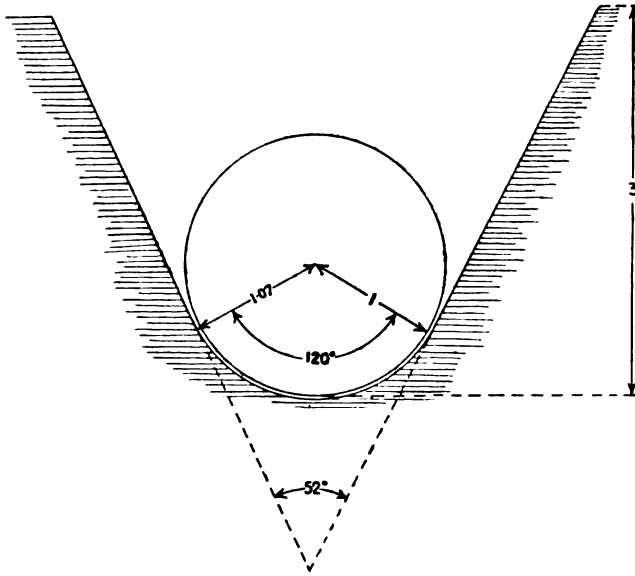


Fig. 124.—Diagrammatic example of a correct sheave for wire rope

Blocks and Sheaves. The sheave over which a rope passes must be examined periodically for :—

- (i) freedom of movement, and to see that all parts are well lubricated and the oil holes clear of paint and dirt ;
- (ii) wear and damage to the grooves, which will quickly ruin any wire rope (the diameter of the grooves must be checked by calipers, and the grooves examined for any " flats ") ;
- (iii) buckling of side plates, as many accidents have been caused by the rope jamming between the sheaves and side plates.

Maintenance

Life of Wire Rope. If not otherwise damaged, the useful life of a wire rope working around sheaves can be estimated from the number of times it will have to bend round a sheave. Also, a relation has been established by experiment between the size of the sheave, the factor of safety, and the resulting life of the rope. For example, a rope of construction 6×37 used on a sheave of diameter equal to six times the circumference of the rope, and loaded to one-eighth of its breaking stress (factor of safety 8) will have a useful life of about 65,000 bends ; and if the diameter is increased to ten times the circumference of the rope the life of the latter increases to 165,000 bends.

In this connection it must be remembered that any particular portion of a rope is bent every time it passes over any sheave, and that a bend of 10° causes nearly the same internal friction and extra stress as a bend of 100° . All bends, however small, must therefore be taken into account.

When a rope passes over one sheave and then over a second sheave in a reverse direction (in the form of a letter S) it is subjected to a form of bending used to break off a single wire. This is known as "reverse bending" and is most detrimental to the life of the rope. Under the least adverse conditions it may halve the life of the rope; and under the worst, i.e. with the sheaves close together, a reasonable life for the rope cannot be expected.

Bad Nips. When a rope is bent too sharply it is said to have a "bad nip", and while in that condition a proportion of its strength is lost and it is very liable to be seriously crippled.

The table below gives the percentage of strength remaining in a new flexible wire rope subjected to various degrees of "bad nip".

<i>Diameter of Curvature</i>	<i>Percentage of Strength Remaining</i>
$C \times \frac{1}{2}$	50
$C \times 1$	75
$C \times 1\frac{1}{2}$	85
$C \times 2$	90
$C \times 2\frac{1}{2}$	95
$C \times 3$	97
$C \times 3\frac{1}{2}$	98
$C \times 4$	99

C = circumference of rope in inches

It will be seen that the strength temporarily lost depends upon the sharpness of the bend and not upon the deflection of the rope; the greater this deflection, however, the greater is the length of rope which will be crippled. In both Figs. 125 (i) and 125 (ii), the loss of strength in the rope will be the same, but in Fig. 125 (ii) a greater length is subject to crippling.

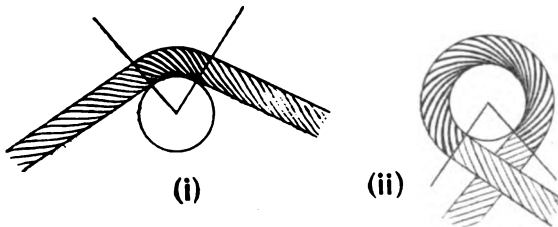


Fig. 125.—Extent of crippling in a wire rope

Other Effects of Mishandling. When a wire rope remains belayed round a bollard for a long time it will tend to take up a set conforming to the shape of the bollard. This set does not, however, become pronounced unless the rope is subjected to stress, and the degree of set induced depends upon the load applied. Should this load be heavy the set will become permanent and the rope is then considered to be "crippled"; a pull of a weight equal to about 50 per cent of the breaking stress of the rope may be expected to have this effect.

Similarly, when a rope is surged under a heavy stress (equal, say, to about 50 per cent of the breaking stress), this permanent set will be induced throughout the part that has been in contact with the bollard. When released it will take the shape of a coiled spring, the coils being the same size as the bollard round which the rope was surged.

Though it certainly makes the rope harder to handle, the crippling just described does not materially reduce its strength unless accompanied by a flattening of the rope and consequent distortion of the strands.

A wire rope which is under a load near the limit of its breaking stress may emit a high-pitched whining note, which is caused by its elongation and the friction set up between its individual wires. If the rope parts, the ends may spring back on their own parts and flail; the more suddenly applied the load, the more liable are the ends to spring back when the rope parts.

A wire rope may show the effects of over-stress in elongation and in a reduction of its diameter. Such rope should be treated with extreme caution.

Corrosion. Wire rope can be corroded by :—

- (i) the action of damp on the wires from which the galvanising has worn off; if this occurs to the inner wires first it causes rust to fall out of the rope and is thus readily noticeable;
- (ii) the action of fumes and funnel gases, which attack the outside wires, the effect thus becoming visible on inspection;
- (iii) contact with acid, which soaks into the heart and attacks the inside wires; this is not necessarily noticeable on the outside of the rope, and so can be the cause of it parting without warning.

Failure. Failure of a rope may be caused by damage, fatigue, worn or damaged sheaves, corrosion or lack of lubrication.

Except for the internal corrosion mentioned in the previous paragraph, and lack of lubrication, the first signs of the effects of these possible causes of failure can be expected to appear on the outside of the rope and thus give visible warning on inspection of the rope.

Inspection and Testing

INSPECTION.

As every departure from the ideal conditions of working results in the reduction in the life of a rope, its frequent and regular inspection is necessary. Under normal conditions of use it is considered that a rope should be inspected every three months during the first half of its life and monthly thereafter (see *Broken wires* below); but a rope which is used for heavy work, or subjected to abuse or illtreatment, must, of course, be examined more frequently.

When inspecting, the indications described below should be sought :—

Distortion of strands. This is the result of damage by kinking, crushing, serious crippling round a bad nip, or other violent treatment; it is commonly found in berthing hawsers, picking-up ropes, and other ropes which have to be worked in adverse conditions.

Kinks need no further remarks, and other distortions are equally serious. If likely to cause the strands to bear unequal stresses they must be considered as reducing the strength of the rope by 30 per cent ; and should they be sufficiently serious to cause the heart to protrude, the portion of the rope affected must be discarded.

A crushed rope may be restored to some extent by the careful use of a mallet.

The flattening of some of the outer wires by abrasion. These " flats " are usually easily seen because the abrasion gives the flattened wires a bright and polished appearance, but they do not affect the strength of the rope unless they are very pronounced. Flats which in extent are three-quarters of the diameter of the wires will reduce their cross sections, and therefore their individual strengths, by 10 per cent, and as only a limited number of wires will be affected the loss in strength of the whole rope will be very small.

These " flats " must not be confused with flattening of the whole rope, which indicates distortion of the strands and is therefore much more serious.

Broken wires. These are usually the result of fatigue and wear, and mostly occur in crane hoists. It is generally accepted, and is in conformity with the Commercial Docks Regulations, that a wire rope has spent half its life when one wire of any strand breaks ; the rope should then be examined more frequently, and, if used for hoisting, it should be discarded if more than 10 per cent of its wires are broken in a length equal to $2\frac{1}{2}$ times the circumference of the rope ; for example, a 3-inch, 6×24 , wire rope should be discarded if 15 broken wires are found in a length of $7\frac{1}{2}$ inches. A berthing hawser would, of course, become impossible to handle long before this number of breaks had occurred ; this condition very seldom arises, however, because such ropes usually come to a violent end before fatigue has time to set in.

Should a suspiciously large proportion of the breaks appear in one strand, less than the above number of broken wires will warrant the rope being discarded.

Breaks due to damage will, of course, be of local significance only, and not typical of any other part of the rope ; if serious, the affected portion of the rope only need be discarded.

Corrosion. As already mentioned, most corrosion is readily noticeable, but any suspicion of contact with acid warrants the most careful examination.

Lack of lubrication is a frequent cause of corrosion. When a wire rope is under tension it stretches and consequently becomes thinner, and during this process the individual wires are compressed and friction is set up ; the fibre hearts and core are also compressed, which squeezes the oil out of them and so provides lubrication at the critical period.

A wire rope of outwardly good appearance, but with a dry or powdery heart or core, should be treated with caution.

Effect of extreme cold. Rope which is subjected to extreme cold such as is met with in the Arctic is liable to become brittle and lose its flexibility ; this may cause an apparently sound rope to part without warning, which should be borne in mind when working ropes in hoists. This effect is not permanent and the rope will regain its resilience under normal temperature.

TESTING

Both before and after galvanising, a sample is taken of each length of 1,500 fathoms or less, and by virtue of the continuity of its construction these samples can be taken as typical of the entire length. From these samples a percentage of wires is tested individually, and a representative portion of the rope is tested to destruction, with the result that the performance of every new wire rope can be guaranteed. The strength of the finished rope depends upon the quality of the wires used, and is calculated from the sum of their cross-sectional areas.

If the strength of a wire rope is suspect it can be subjected to its proof load, which is generally two-fifths of its breaking stress.

SIZES, WEIGHTS, AND BREAKING STRESSES OF NATURAL AND ROT-PROOFED HAWSER-LAID CORDAGE

Notes (i) Breaking stresses given below are taken from Admiralty specifications to manufacturers, and are correct for *new rope*.
(ii) All hawser-laid cordage is supplied in coils of 120 fathoms.

SIZE		MANILA AND SISAL— NATURAL OR ROT-PROOFED		MANILA— SPECIAL, ROT-PROOFED		ITALIAN HEMP— NATURAL		COIR		SIZE	
Circ.	Diameter	Weight lb./10 fm.	Br. Str. ton cwt.	Weight lb./10 fm.	Br. Str. ton cwt.	Weight lb./10 fm.	Br. Str. ton cwt.	Weight lb./10 fm.	Br. Str. ton cwt.	Circ.	in.
$\frac{1}{8}$	$\frac{1}{8}$	0.9	0 3	—	—	* 0.9	* 0 4 $\frac{1}{2}$	—	—	$\frac{1}{8}$	$\frac{1}{8}$
$\frac{7}{16}$	$\frac{7}{16}$	1.3	0 6	1.3	0 7 $\frac{1}{2}$	† 1.9	† 0 9	—	—	$\frac{7}{16}$	$\frac{7}{16}$
1	$\frac{1}{4}$	2.2	0 9	2.2	0 10 $\frac{1}{2}$	2.3	0 12	—	—	1	1
$1\frac{1}{4}$	$\frac{3}{8}$	2.8	0 14	2.8	0 15 $\frac{1}{2}$	3.0	0 15	—	—	$1\frac{1}{4}$	$1\frac{1}{4}$
$1\frac{1}{2}$	$\frac{7}{16}$	—	—	3.5	0 17 $\frac{1}{2}$	—	—	—	—	$1\frac{1}{2}$	$1\frac{1}{2}$
$1\frac{3}{4}$	$\frac{1}{2}$	4.3	1 0	4.3	1 2 $\frac{1}{2}$	5.0	1 1	2.3	0 4	$1\frac{3}{4}$	$1\frac{3}{4}$
$1\frac{7}{8}$	$\frac{9}{16}$	—	—	4.8	1 4 $\frac{1}{2}$	—	—	—	—	$1\frac{7}{8}$	$1\frac{7}{8}$
$1\frac{1}{2}$	$\frac{5}{8}$	5.6	1 7	5.6	1 9 $\frac{1}{2}$	6.3	1 8	—	—	$1\frac{1}{2}$	$1\frac{1}{2}$
2	$\frac{3}{4}$	7.7	1 15	7.7	2 0	8.0	1 17	4.0	0 7	2	2
$2\frac{1}{4}$	$\frac{7}{8}$	9.0	2 5	9.0	2 8	9.8	2 7	—	—	$2\frac{1}{4}$	$2\frac{1}{4}$
$2\frac{1}{2}$	$\frac{15}{16}$	11.8	2 15	11.8	3 3	12.5	2 18	6.3	0 11	$2\frac{1}{2}$	$2\frac{1}{2}$
$2\frac{3}{4}$	$\frac{1}{2}$	13.9	3 7	13.9	3 15	15.1	3 11	—	—	$2\frac{3}{4}$	$2\frac{3}{4}$
3	$\frac{1}{2}$	16.7	4 0	16.7	4 10	17.8	4 4	9.0	0 15	3	3
$3\frac{1}{4}$	$1\frac{1}{8}$	19.3	4 8	19.3	5 2	—	—	—	—	$3\frac{1}{4}$	$3\frac{1}{4}$
$3\frac{1}{2}$	$1\frac{1}{4}$	22.5	5 2	22.5	5 19	24.3	5 12	12.3	1 0	$3\frac{1}{2}$	$3\frac{1}{2}$
$3\frac{3}{4}$	$1\frac{3}{8}$	25.8	5 17	25.8	6 16	—	—	—	—	$3\frac{3}{4}$	$3\frac{3}{4}$
4	$1\frac{1}{2}$	30.0	6 13	30.0	7 13	31.3	7 5	16.0	1 7	4	4
$4\frac{1}{4}$	$1\frac{5}{8}$	33.3	7 10	33.3	8 11	—	—	—	—	$4\frac{1}{4}$	$4\frac{1}{4}$
$4\frac{1}{2}$	$1\frac{3}{4}$	37.5	8 9	37.5	9 11	39.6	9 5	20.3	1 14	$4\frac{1}{2}$	$4\frac{1}{2}$
$4\frac{3}{4}$	$1\frac{7}{8}$	41.8	9 0	41.8	10 11	—	—	—	—	$4\frac{3}{4}$	$4\frac{3}{4}$
5	$1\frac{1}{2}$	46.7	10 0	46.7	11 13	49.1	11 10	25.0	2 2	5	5
$5\frac{1}{4}$	$1\frac{3}{4}$	50.8	11 0	—	—	—	—	—	—	$5\frac{1}{4}$	$5\frac{1}{4}$
$5\frac{1}{2}$	$1\frac{1}{2}$	55.8	12 2	55.8	13 19	59.7	13 15	—	—	$5\frac{1}{2}$	$5\frac{1}{2}$
$5\frac{3}{4}$	$1\frac{7}{8}$	60.8	13 0	—	—	—	—	—	—	$5\frac{3}{4}$	$5\frac{3}{4}$

* $\frac{1}{2}$ -in. circumference.† $\frac{1}{4}$ -in. circumference.

in.	in.	lb./10 fm.	ton	cwt.	lb./10 fm.	ton	cwt.	lb./10 fm.	ton	cwt.	lb./10 fm.	ton	cwt.	in.
6	1 $\frac{1}{8}$	66.7	14	0	66.7	16	19	70.8	16	10	36.0	3	0	6
6 $\frac{1}{2}$	2 $\frac{1}{16}$	78.3	16	9	78.3	19	3	—	—	—	—	—	—	6 $\frac{1}{2}$
7	2 $\frac{1}{4}$	90.8	19	1	90.8	22	1	96.3	20	0	49.0	4	0	7
7 $\frac{1}{2}$	2 $\frac{3}{8}$	104.3	21	18	—	—	—	—	—	—	—	—	—	7 $\frac{1}{2}$
8	2 $\frac{1}{2}$	118.3	24	18	118.3	28	7	126.1	26	0	64.0	5	5	8
8 $\frac{1}{2}$	2 $\frac{3}{4}$	134.2	27	18	—	—	—	—	—	—	—	—	—	8 $\frac{1}{2}$
9	2 $\frac{7}{8}$	150.0	31	2	150.0	35	9	159.3	33	0	81.0	6	12	9
9 $\frac{1}{2}$	3 $\frac{1}{8}$	167.5	34	14	—	—	—	—	—	—	—	—	—	9 $\frac{1}{2}$
10	3 $\frac{3}{8}$	185.0	38	4	185.0	43	9	196.9	40	15	100.0	8	2	10
11	3 $\frac{1}{2}$	224.2	46	3	224.2	52	4	238.0	49	5	118.7	9	15	11
12	3 $\frac{5}{8}$	283.3	54	14	283.3	61	18	283.3	58	10	144.0	11	14	12
13	4 $\frac{1}{8}$	313.3	64	1	313.3	72	5	332.1	68	10	169.0	13	12	13
14	4 $\frac{3}{8}$	363.3	74	0	363.3	83	5	385.2	79	5	196.0	15	13	14
15	4 $\frac{7}{8}$	416.7	84	12	416.7	95	13	442.6	90	0	226.0	18	2	15
16	5 $\frac{1}{8}$	474.2	95	19	474.2	108	11	504.1	107	0	256.0	20	12	16
17	5 $\frac{3}{8}$	534.3	107	18	534.3	122	1	—	—	—	289.0	23	4	17
18	5 $\frac{7}{8}$	605.0	120	11	605.0	136	14	—	—	—	324.0	26	1	18
19	6 $\frac{1}{16}$	668.3	134	0	—	—	—	—	—	—	361.0	29	0	19
20	6 $\frac{3}{8}$	740.8	148	0	—	—	—	—	—	—	400.0	32	3	20
21	6 $\frac{7}{8}$	—	—	—	—	—	—	—	—	—	441.0	35	9	21
22	7	—	—	—	—	—	—	—	—	—	484.0	38	18	22

Comparison with specifications of the British Standard Institute for hawser-laid cordage :—

- (i) *Manila and Hemp*. B.S.I. has three specifications, namely : Grade I (Special), Grade II (Standard) and Grade III (Merchant). The breaking stress of Grade I is 9/8ths of that of Grade II ; the breaking stress of Grade III is 7/8ths of that of Grade II. Admiralty manila ropes (natural or rot-proofed) and Admiralty Italian hemp ropes (natural) correspond in strength generally with commercial manila and hemp ropes (natural) of Grade II quality. Admiralty manila rope (special) corresponds with commercial manila rope of Grade I quality.
- (ii) *Sisal (natural or rot-proofed) and Coir*. B.S.I. has only one specification for each of these types of rope. Admiralty sisal (natural or rot-proofed) and coir ropes correspond in strength closely with commercial sisal (natural) and coir ropes manufactured in accordance with the B.S.I. Specifications.

SIZES, WEIGHTS, AND BREAKING STRESSES OF TARRED HAWSER-LAID CORDAGE

Notes (i) Breaking stresses given below are taken from Admiralty specifications to manufacturers, and are correct for *new rope*.
(ii) All hawser-laid cordage is supplied in coils of 120 fathoms.

SIZE		TARRED SISAL*		TARRED ITALIAN HEMP*		TARRED EUROPEAN HEMP*		SIZE
Circumference	Diameter	Weight	Breaking stress	Weight	Breaking stress	Weight	Breaking stress	Circumference
in.	in.	lb./10 fm.	ton cwt.	lb./10 fm.	ton cwt.	lb./10 fm.	ton cwt.	in.
$\frac{1}{2}$	$\frac{5}{16}$	1.0	0 2½	1.2	0 3½	1.2	0 3	$\frac{1}{2}$
$\frac{3}{4}$	$\frac{1}{4}$	1.5	0 5½	2.4	0 7½	2.4	0 6	$\frac{3}{4}$
1	$\frac{3}{8}$	2.6	0 8	3.0	0 9½	3.0	0 8	1
1½	$\frac{7}{16}$	3.3	0 10	4.0	0 12½	4.0	0 10	1½
1½	$\frac{9}{16}$	5.5	0 16	6.4	0 19	6.4	0 15	1½
1¾	$\frac{1}{2}$	6.9	1 2	8.2	1 3	8.2	1 0	1¾
2	$\frac{5}{8}$	8.9	1 9	10.4	1 10	10.4	1 7	2
2½	$\frac{3}{4}$	10.7	1 16	—	—	12.8	1 14	2½
2½	$\frac{13}{16}$	14.0	2 5	16.2	2 10	16.2	2 0	2½
2¾	$\frac{7}{8}$	16.7	2 14	—	—	19.8	2 10	2¾
3	$\frac{15}{16}$	20.0	3 4	23.2	3 10	23.2	3 0	3
3½	1½	27.2	4 1	31.5	4 12	31.5	3 18	3½

<i>in.</i>	<i>in.</i>	<i>lb./10 fm.</i>	<i>ton</i>	<i>wt.</i>	<i>lb./10 fm.</i>	<i>ton</i>	<i>wt.</i>	<i>lb./10 fm.</i>	<i>ton</i>	<i>wt.</i>	<i>in.</i>
4	1 $\frac{3}{16}$	35.2	5	6	40.8	6	0	40.8	5	0	4
4 $\frac{1}{2}$	1 $\frac{7}{16}$	44.8	6	14	51.4	7	12	51.4	6	9	4 $\frac{1}{2}$
5	1 $\frac{1}{8}$	55.2	8	5	63.8	9	10	63.8	7	18	5
5 $\frac{1}{2}$	1 $\frac{3}{8}$	67.2	10	0	77.6	11	10	77.6	9	15	5 $\frac{1}{2}$
6	1 $\frac{1}{2}$	80.0	11	4	92.1	13	10	92.1	11	10	6
6 $\frac{1}{2}$	2 $\frac{1}{16}$	—	—	—	—	—	—	107.1	12	16	6 $\frac{1}{2}$
7	2 $\frac{1}{4}$	108.8	15	5	—	—	—	124.4	14	16	7
7 $\frac{1}{2}$	2 $\frac{1}{2}$	—	—	—	—	—	—	142.8	17	0	7 $\frac{1}{2}$
8	2 $\frac{3}{8}$	142.3	19	18	—	—	—	163.9	19	8	8
8 $\frac{1}{2}$	2 $\frac{1}{2}$	—	—	—	—	—	—	185.0	21	10	8 $\frac{1}{2}$
9	2 $\frac{7}{8}$	180.0	24	6	—	—	—	207.2	24	0	9
10	3 $\frac{1}{16}$	222.3	30	0	—	—	—	256.0	30	0	10
11	3 $\frac{1}{2}$	268.8	36	6	—	—	—	309.4	36	10	11
12	3 $\frac{3}{8}$	320.0	43	4	—	—	—	368.3	43	10	12
13	4 $\frac{1}{32}$	375.2	50	14	—	—	—	431.8	51	0	13
14	4 $\frac{1}{16}$	435.3	58	16	—	—	—	—	—	—	14
15	4 $\frac{3}{16}$	500.0	67	10	—	—	—	—	—	—	15
16	5 $\frac{3}{32}$	568.8	76	16	—	—	—	—	—	—	16

* All tarred hawser-laid cordage is now (1950) obsolescent in the Royal Navy.

SIZES, WEIGHTS, AND BREAKING STRESSES OF NATURAL, ROT-PROOFED, AND TARRED CABLE-LAID CORDAGE

158

Notes (i) Breaking stresses given below are taken from Admiralty specifications to manufacturers, and are correct for *new rope*.

(ii) All cable-laid cordage is supplied in coils of 100 fathoms.

SIZE		MANILA—NATURAL, SISAL—NATURAL OR ROT-PROOFED			MANILA—NATURAL* (old standard)		SISAL—TARRED*		EUROPEAN HEMP— TARRED*		SIZE
Circ.	Diameter	Weight	Br. Str.	ton	Weight	Br. Str.	Weight	Br. Str.	Weight	Br. Str.	Circ.
<i>in.</i>	<i>in.</i>	<i>lb./10 fm.</i>	<i>lb./10 fm.</i>	<i>ton</i>	<i>lb./10 fm.</i>	<i>ton</i>	<i>lb./10 fm.</i>	<i>ton</i>	<i>lb./10 fm.</i>	<i>ton</i>	<i>in.</i>
6	1 $\frac{7}{8}$	63·0	9	0	57·9	9	75·0	7	—	—	6
6 $\frac{1}{2}$	2 $\frac{1}{16}$	—	—	—	69·5	11	—	—	—	—	6 $\frac{1}{2}$
7	2 $\frac{1}{4}$	84·0	12	5	80·7	13	103·6	9	—	—	7
7 $\frac{1}{2}$	2 $\frac{3}{8}$	—	—	—	91·9	14	—	—	—	—	7 $\frac{1}{2}$
8	2 $\frac{1}{2}$	111·0	16	0	103·1	16	132·5	12	—	—	8
8 $\frac{1}{2}$	2 $\frac{3}{4}$	—	—	—	115·5	18	—	—	—	—	8 $\frac{1}{2}$
9	2 $\frac{7}{8}$	141·0	20	5	132·2	21	169·9	16	—	—	9
9 $\frac{1}{2}$	3 $\frac{1}{8}$	—	—	—	—	—	—	—	—	—	9 $\frac{1}{2}$
10	3 $\frac{1}{4}$	174·0	24	18	163·6	25	210·5	20	225·8	22	10
10 $\frac{1}{2}$	3 $\frac{3}{8}$	—	—	—	—	—	—	—	247·4	24	10 $\frac{1}{2}$
11	3 $\frac{1}{2}$	210·0	29	17	197·2	30	253·7	24	272·1	27	11
12	3 $\frac{3}{4}$	249·0	35	4	233·0	36	299·8	28	321·5	32	12

in.	in.	lb./10 fm.	ton	cwt.	lb./10 fm.	ton	cwt.	lb./10 fm.	ton	cwt.	lb./10 fm.	ton	cwt.	in.
13	4 $\frac{1}{8}$	294-0	41	6	275-6	42	17	354-5	33	16	380-2	37	10	13
14	4 $\frac{1}{4}$	342-0	47	15	318-1	49	7	409-3	39	4	439-0	45	0	14
15	4 $\frac{3}{8}$	390-0	54	3	365-2	56	13	469-7	45	0	503-7	52	0	15
16	5 $\frac{1}{8}$	447-0	60	13	—	—	—	536-0	51	4	—	—	—	16
17	5 $\frac{3}{8}$	504-0	69	2	—	—	—	605-1	57	16	—	—	—	17
18	5 $\frac{7}{8}$	564-0	77	0	—	—	—	677-1	64	17	—	—	—	18
19	6 $\frac{1}{8}$	627-0	85	5	—	—	—	—	—	—	—	—	—	19
20	6 $\frac{3}{8}$	696-0	94	4	—	—	—	—	—	—	—	—	—	20
21	6 $\frac{7}{8}$	768-0	103	10	—	—	—	—	—	—	—	—	—	21
22	7	843-0	113	3	—	—	—	—	—	—	—	—	—	22
23	7 $\frac{1}{8}$	921-0	123	1	—	—	—	—	—	—	—	—	—	23
24	7 $\frac{3}{8}$	1002-0	132	8	—	—	—	—	—	—	—	—	—	24

* This rope is now (1950) obsolescent in the Royal Navy.

Comparison with specifications of the British Standard Institute for cable-laid cordage :—

- (i) *Manila and Hemp*. B.S.I. has three specifications, namely : Grade I (Special), Grade II (Standard), and Grade III (Merchant). The breaking stress of Grade I is 9/8ths of that of Grade II ; the breaking stress of Grade III is 7/8ths of that of Grade II. Admiralty manila rope, natural (as shown in first table above), corresponds in strength generally with commercial manila rope (natural) of Grade II quality. Admiralty manila rope, natural—old standard (as shown in second table above) and Admiralty European hemp rope, tarred (as shown in fourth table above) correspond in strength generally with commercial manila rope (natural) and commercial European hemp rope (tarred) of Grade I quality.
- (ii) *Sisal (natural or tarred)*. B.S.I. has only one specification for each of these types of rope, and Admiralty sisal ropes (natural, rot-proofed or tarred) correspond in strength closely with commercial sisal ropes (natural or tarred) manufactured in accordance with the B.S.I. specifications.

SIZES, WEIGHTS, AND BREAKING STRESSES OF NATURAL, ROT-PROOFED, AND TARRED SHROUD-LAID CORDAGE

Notes

- (i) Breaking stresses given below are taken from Admiralty specifications to manufacturers, and are correct for *new rope*.
 (ii) All shroud-laid rope is supplied in coils of 113 fathoms.

SIZE		MANILA—NATURAL* SISAL—NATURAL OR ROT-PROOFED		ITALIAN HEMP— NATURAL†		EUROPEAN HEMP— TARRED†		SISAL— TARRED†		SIZE
Circ.	Diameter	Weight	Br. Str.	Weight	Br. Str.	Weight	Br. Str.	Weight	Br. Str.	Circ.
in.	in.	lb./10 fm.	ton cut.	lb./10 fm.	ton cut.	lb./10 fm.	ton cut.	lb./10 fm.	ton cut.	in.
1½	1½	4.4	0 18	4.6	0 19	5.9	0 13½	5.5	0 15	1½
1½	1½	6.3	1 4	6.4	1 5	8.3	0 19	7.7	1 0	1½
2	2	8.4	1 12	7.8	1 13	10.0	1 4	9.3	1 6	2
2½	2½	10.6	2 0	10.4	2 2	13.5	1 10	12.3	1 14	2½
2½	2½	12.6	2 10	12.7	2 12	16.5	1 18	15.2	2 1	2½
2½	2½	14.8	2 0	15.2	3 4	20.0	2 5	18.5	2 10	2½
3	3	17.9	3 12	17.9	3 16	23.2	2 14	21.4	3 0	3
3½	3½	24.5	4 12	24.5	5 0	31.9	3 10	29.3	3 13	3½
4	4	31.6	6 0	31.2	6 0	40.6	4 12	37.4	4 16	4
4½	4½	39.7	7 12	39.7	8 0	51.5	5 16	47.5	6 1	4½
5	5	49.3	9 8	49.3	10 0	63.7	7 5	58.9	7 10	5
5½	5½	60.4	11 7	60.3	12 0	78.1	8 15	72.0	9 1	5½
6	6	71.7	13 12	—	—	92.3	10 5	85.2	10 16	6
6½	6½	83.9	15 0	—	—	—	—	—	—	6½
7	7	97.0	17 8	—	—	125.1	14 0	115.5	14 14	7
7½	7½	111.4	20 0	—	—	—	—	—	—	7½
8	8	127.7	22 15	155.7	18 5	206.9	23 2	151.9	19 4	8
9	9	160.5	28 13	—	—	—	—	191.0	24 6	9
10	10	198.4	35 1	—	—	254.9	28 10	236.0	30 0	10
11	11	240.4	42 6	309.6	34 10	368.9	34 10	285.8	36 6	11
12	12	287.3	50 6	—	—	—	41 0	340.5	43 4	12

* Shroud-laid natural manila rope is only supplied in sizes from 3 in. to 8 in. inclusive.

† These ropes are now (1950) obsolescent in the Royal Navy.

SIZES, WEIGHTS, AND BREAKING STRESSES OF NATURAL, ROT-PROOFED AND TARRED BOLTROPE

Notes (i) Breaking stresses given below are taken from Admiralty specifications to manufacturers and are correct for *new rope*.
(ii) All boltrope is supplied in coils of 120 fathoms.

SIZE		SISAL—ROT-PROOFED OR NATURAL		HEMP—ROT-PROOFED, AND ITALIAN HEMP—NATURAL		ITALIAN HEMP—TARRED		SISAL—TARRED**		SIZE
Circ.	Diameter	Weight	Br. Str.	Weight	Br. Str.	Weight	Br. Str.	Weight	Br. Str.	Circ.
in.	in.	lb./10 fm.	ton cwt.	lb./10 fm.	ton cwt.	lb./10 fm.	ton cwt.	lb./10 fm.	ton cwt.	in.
1	$\frac{1}{8}$	0.8	0 3	0.9*	0 4*	1.2*	0 3 $\frac{1}{2}$ *	1.0*	0 2 $\frac{1}{2}$ *	$\frac{1}{8}$
1 $\frac{1}{2}$	$\frac{1}{4}$	1.3	0 6	1.7†	0 8†	2.3†	7 7 $\frac{1}{2}$ †	1.5†	0 5 $\frac{1}{2}$ †	$\frac{1}{4}$
2	$\frac{3}{8}$	2.0	0 9	2.2	0 12	2.8	0 9†	2.6	0 8	1
2 $\frac{1}{2}$	$\frac{1}{2}$	2.8	0 14	2.8	0 15	3.8	0 12 $\frac{1}{2}$	3.5	0 10	1 $\frac{1}{2}$
3	$\frac{5}{8}$	4.3	1 0	4.6	1 2	5.9	0 19	5.5	0 16	1 $\frac{3}{4}$
3 $\frac{1}{2}$	$\frac{3}{4}$	5.5	1 7	5.8	1 10	7.6	1 3	7.0	1 2	2
4	$\frac{7}{8}$	7.1	1 15	7.5	1 17	9.8	1 10	9.0	1 9	2 $\frac{1}{2}$
4 $\frac{1}{2}$	1	8.8	2 5	9.1	2 7	11.8	1 18	11.0	1 16	3
5	1 $\frac{1}{8}$	11.5	2 15	11.5	2 18	14.9	2 10	14.0	2 5	3 $\frac{1}{2}$
5 $\frac{1}{2}$	1 $\frac{1}{4}$	13.7	3 7	14.0	3 14	18.2	3 0	17.0	2 14	4
6	1 $\frac{3}{8}$	16.4	4 0	16.4	4 8	21.3	3 10	19.8	3 4	4 $\frac{1}{2}$
	1 $\frac{1}{2}$	22.4	5 2	22.4	5 11	29.2	4 12	27.0	4 1	5
	1 $\frac{5}{8}$	29.0	6 13	29.0	7 5	37.7	6 0	34.8	5 6	5 $\frac{1}{2}$
	1 $\frac{7}{8}$	36.6	8 9	36.6	9 3	47.7	7 12	44.0	6 14	6
	2	45.3	10 0	45.3	11 7	59.0	9 10	54.5	8 5	
	2 $\frac{1}{8}$	55.2	12 2	55.2	13 14	71.8	11 10	66.3	10 0	
	2 $\frac{1}{4}$	65.6	14 8	65.6	16 6	86.3	13 10	78.8	12 0	

* $\frac{1}{8}$ -in. circumference.

† $\frac{1}{4}$ -in. circumference.

** These ropes are now (1950) obsolescent in the Royal Navy.

SIZES, WEIGHTS, AND BREAKING STRESSES OF STAGE LASHING, SIGNAL HALYARD, AND HAND-LEAD LINE

Notes (i) Breaking stresses given below are taken from Admiralty specifications to manufacturers, and are correct for *new rope*.
(ii) Stage lashing is supplied in coils of 125 fathoms; signal halyard is supplied in coils of 122 fathoms; hand-lead line is supplied in coils of 113 fathoms.

STAGE LASHING									
SIZE		SISAL—ROT-PROOFED		SISAL—TARRED*		HEMP—TARRED*		SIZE	
Circumference	Diameter	Weight	Br. Str.	Weight	Br. Str.	Weight	Br. Str.	Circumference	
<i>in.</i>	<i>in.</i>	<i>lb./10 fm.</i>	<i>ton cul.</i>	<i>lb./10 fm.</i>	<i>ton cul.</i>	<i>lb./10 fm.</i>	<i>ton cul.</i>	<i>in.</i>	
1½	½	3·4	0 14	3·8	0 10	—	—	1½	
1½	½	4·8	1 0	5·8	0 15	6·3	0 14	1½	
2	¾	7·2	1 15	8·6	1 7	9·6	1 5	2	
3	1	16·0	4 0	19·2	3 0	20·0	2 15	3	
3½	1½	21·6	5 2	26·0	4 1	28·2	3 15	3½	
4	1½	28·2	6 13	34·6	5 6	37·6	4 18	4	
4½	1½	36·0	8 9	43·2	6 14	46·9	6 5	4½	
5	1½	44·8	10 0	53·8	8 5	58·4	7 14	5	
5½	1½	53·6	12 2	64·3	10 0	69·7	9 5	5½	
6	1½	64·0	14 0	76·8	12 0	84·0	10 15	6	

* Stage lashing made of tarred hemp or tarred sisal is now (1950) obsolescent in the Royal Navy.

SIGNAL HALYARD				HAND-LEAD LINE			
SISAL—NATURAL OR ROT-PROOFED		SISAL—NATURAL OR ROT-PROOFED		SISAL—NATURAL OR ROT-PROOFED		SIZE	
Weight	Br. Str.	Weight	Br. Str.	Weight	Br. Str.	Circumference	
<i>lb./10 fm.</i>	<i>ton cul.</i>	<i>lb./10 fm.</i>	<i>ton cul.</i>	<i>lb./10 fm.</i>	<i>ton cul.</i>	<i>in.</i>	
1·6	0 8	—	—	—	—	¾	
2·2	0 12	2·4	0 14	—	—	1½	
2·9	0 16	—	—	—	—	1½	

TYPES, SUPPLY, AND BREAKING STRESSES OF SMALL STUFF

TYPE	HOW SUPPLIED	BREAKING STRESS	TYPE	HOW SUPPLIED	BREAKING STRESS
<i>Patent Log Line</i>	Coils of 70 fm., 65 fm., 50 fm. and 40 fm.—size 1½ in.	lb. 1,000	<i>Marline</i> Italian	Hanks of 1 lb.; length or runnage 60 yd.	lb. 280
<i>White Lines</i>	Hanks of 20 fm. and designated by the weight of a hank, <i>e.g.</i> , 2½ lb., 1 lb., 1½ lb., 2 lb., 2½ lb., 3 lb., 4 lb.	145 325 430 580 720 810 980 1,035	Tarred European, New Zealand & St. Helena	Hanks of 1 lb.; length or runnage 57 yd.	150
<i>Fishing Line</i>			<i>Housetine</i> Italian White	Hanks of 1 lb.; length or runnage 75 yd.	350
Whiting Line	Hanks of 20 fm.—2 oz.	48	European Tarred	Hanks of 1 lb.; length or runnage 70 yd.	125
Mackerel line	Hanks of 30 fm.—¾ lb.	140		Hanks of ¾ lb.; length or runnage 380 yd.	50
Cod line	Hanks of 40 fm.—2½ lb.	320	<i>Roping Twine</i>		
Albicore line	Hanks of 30 fm.—2½ lb.	420	<i>Seaming Twine</i> Extra Coarse	Hanks of 1 lb. or coils of ¾ lb.; length or runnage per lb. 376 yd.	80
<i>Spunyarn</i>	Pads or coils of 56 lb. Length of coil varies from 187 fm. to 1870 fm. Those most commonly used are about half way between these limits.	—	Coarse	Hanks of 1 lb. or coils of ¾ lb.; length or runnage per lb. 540 yd.	45
<i>Nettlestuff</i> White	Coils or pads of 14 lb. Length 3-yarn 400 fm. and 2-yarn 600 fm.	—	Extra Medium	Hanks of 1 lb. or coils of ¾ lb.; length or runnage per lb. 640 yd.	40
Tarred	Coils or pads of 14 lb. Length 3-yarn 308 fm. and 2-yarn 462 fm.	—	Medium	Hanks of 1 lb. or coils of ¾ lb.; length or runnage per lb. 720 yd.	38
<i>Hambroline</i> White and Tarred	Coils and pads of 2 lb. and 1 lb. Lengths 34½ yd. and 13½ yd.	430 390	Fine	Hanks of 1 lb. or coils of ¾ lb.; length or runnage per lb. 1120 yd.	26
			Extra Fine	Hanks of 1 lb. or coils of ¾ lb.; length or runnage per lb. 1280 yd.	22
			<i>Seine Twine</i>	Hanks of ¾ lb.; length or runnage per lb. 360 yd.	50

SIZES, CONSTRUCTION, STRENGTHS, LENGTHS AND WEIGHTS OF WIRE ROPE

TYPE	SIZE	CONSTRUCTION	LENGTH OF COIL	WEIGHT PER 10 FATHOMS	BREAKING STRESS	SIZE
	<i>in.</i>		<i>fm.</i>	<i>lb.</i>	<i>tons</i>	<i>in.</i>
STEEL WIRE ROPE FOR STANDING RIGGING	$\frac{3}{4}$	6×7	200	5 $\frac{1}{2}$	1.6	$\frac{3}{4}$
	1	6×7	200	10 $\frac{1}{2}$	3.2	1
	1 $\frac{1}{2}$	6×7	200	15	4.8	1 $\frac{1}{2}$
	1 $\frac{1}{2}$	6×7	200	20	6.25	1 $\frac{1}{2}$
	1 $\frac{3}{4}$	6×7	200	28 $\frac{1}{2}$	8.75	1 $\frac{3}{4}$
	2	6×7	200	37 $\frac{1}{2}$	11.5	2
	2 $\frac{1}{2}$	6×7	200	57 $\frac{1}{2}$	17.75	2 $\frac{1}{2}$
	3	6×7	200	85	26	3
	3 $\frac{1}{2}$	6×7	150	115	35	3 $\frac{1}{2}$
	4	6×19	150	155	45	4
	4 $\frac{1}{2}$	6×19	150	192 $\frac{1}{2}$	57	4 $\frac{1}{2}$
FLEXIBLE STEEL WIRE ROPE FOR HAWSERS AND RUNNING RIGGING	1	6×12	300	7 $\frac{1}{2}$	2.25	1
	1 $\frac{1}{2}$	6×12	300	10	3.25	1 $\frac{1}{2}$
	1 $\frac{1}{2}$	6×12	300	15	4.8	1 $\frac{1}{2}$
	1 $\frac{3}{4}$	6×12	300	20	6.25	1 $\frac{3}{4}$
	2	6×12	300	27 $\frac{1}{2}$	8.5	2
	2 $\frac{1}{2}$	6×12	360	42	13.2	2 $\frac{1}{2}$
	2 $\frac{1}{2}$	6×24	200	57	18	2 $\frac{1}{2}$
	3	6×12	360	60	18.75	3
	3 $\frac{1}{2}$	6×12	360	84	25.7	3 $\frac{1}{2}$
	4	6×12	240 or 360	107 $\frac{1}{2}$	33.5	4
	4 $\frac{1}{2}$	6×12		140	48.5	4 $\frac{1}{2}$
	5	6×24	150	215	68	5
	5 $\frac{1}{2}$	6×24	150	160	81.5	5 $\frac{1}{2}$
	6	6×30	150	310	97.5	6
	6 $\frac{1}{2}$	6×30	150	350	110	6 $\frac{1}{2}$
	6 $\frac{3}{4}$	6×30	150	379	119.5	6 $\frac{3}{4}$
	8	6×30	150	530	170	8
STEEL WIRE ROPE FOR LIFTS (LANG'S LAY)	$\frac{3}{4}$	6×19	300	5.4	1.6	$\frac{3}{4}$
	1	6×19	300	10.8	2.9	1
	1 $\frac{1}{2}$	6×19	300	12.6	3.5	1 $\frac{1}{2}$
	1 $\frac{3}{4}$	6×19	300	15	4.5	1 $\frac{3}{4}$
	1 $\frac{1}{2}$	6×19	300	21.6	6.4	1 $\frac{1}{2}$
	1 $\frac{3}{4}$	6×19	300	30	8.6	1 $\frac{3}{4}$
	2	6×19	300	36	11.2	2
	2 $\frac{1}{2}$	6×19	300	58	17.5	2 $\frac{1}{2}$
	2 $\frac{1}{2}$	6×27	—	58	22.75	2 $\frac{1}{2}$
SPECIAL MINE- SWEEPING ROPE	2 $\frac{1}{2}$	6×19	750	60	19	2 $\frac{1}{2}$
FLEXIBLE MILD STEEL WIRE ROPE AND STRANDS FOR SEIZING	$\frac{1}{16}$	1×6	100	1.3	2 cwt.	$\frac{1}{16}$
	$\frac{1}{8}$	1×10	100	2.05	3 $\frac{1}{2}$ cwt.	$\frac{1}{8}$
	$\frac{1}{4}$	4×4	100	3.3	5 $\frac{1}{2}$ cwt.	$\frac{1}{4}$
	$\frac{3}{8}$	4×6	100	5.0	8 cwt.	$\frac{3}{8}$
	1	4×10	100	8.15	13 cwt.	1
	1 $\frac{1}{2}$	4×16	100	13.15	21 cwt.	1 $\frac{1}{2}$

Note.— $\frac{1}{4}$ inch and above has a jute core.

SIZES, CONSTRUCTION, STRENGTHS, LENGTHS AND WEIGHTS OF WIRE ROPE (*cont.*)

TYPE	SIZE	CONSTRUCTION	LENGTH OF COIL	WEIGHT PER 10 FATHOMS	BREAKING STRESS	SIZE
	<i>in.</i>		<i>fm.</i>	<i>lb.</i>	<i>tons</i>	<i>in.</i>
EXTRA SPECIAL FLEXIBLE STEEL WIRE ROPE FOR HOISTS AND OTHER SPECIAL PURPOSES	$\frac{3}{8}$	6 × 19	100	1.35	0.5	$\frac{3}{8}$
	$\frac{1}{2}$	6 × 19	100	2.3	0.9	$\frac{1}{2}$
	$\frac{5}{8}$	6 × 19	100	3.5	1.4	$\frac{5}{8}$
	$\frac{3}{4}$	6 × 19	100	5.1	2.05	$\frac{3}{4}$
	$\frac{7}{8}$	6 × 24	100	6.8	2.75	$\frac{7}{8}$
	1	6 × 24	300	8.9	3.6	1
	$1\frac{1}{8}$	6 × 24	300	11.2	4.4	$1\frac{1}{8}$
	$1\frac{1}{4}$	6 × 37	300	14.0	5.75	$1\frac{1}{4}$
	$1\frac{3}{8}$	6 × 37	300	17.0	7.0	$1\frac{3}{8}$
	$1\frac{1}{2}$	6 × 37	300	21.0	8.25	$1\frac{1}{2}$
	$1\frac{3}{4}$	6 × 37	300	29.0	11.25	$1\frac{3}{4}$
	$1\frac{7}{8}$	6 × 37	300	35.0	12.8	$1\frac{7}{8}$
	2	6 × 37	300	39.0	14.7	2
	$2\frac{1}{8}$	6 × 37	300	48.0	18.3	$2\frac{1}{8}$
	$2\frac{1}{4}$	6 × 37	300	59.0	22.75	$2\frac{1}{4}$
	$2\frac{3}{8}$	6 × 37	300	73.0	27.5	$2\frac{3}{8}$
	3	6 × 37	150	87.0	33.0	3
	$3\frac{1}{8}$	6 × 37	150	103.0	39.0	$3\frac{1}{8}$
	$3\frac{1}{4}$	6 × 37	150 or 450	115.0	45.0	$3\frac{1}{4}$
	4	6 × 37	150 or 120	153.0	58.0	4
	$4\frac{1}{8}$	6 × 37	150	173.0	65.5	$4\frac{1}{8}$
	$4\frac{1}{4}$	6 × 37	150	191.0	73.0	$4\frac{1}{4}$
	5	6 × 37	150	235.0	90.0	5
	6	6 × 37	150	354.0	130.3	6
	$6\frac{1}{8}$	6 × 37	150	409.0	151.4	$6\frac{1}{8}$
	$6\frac{1}{4}$	6 × 61	150	450.0	170.0	$6\frac{1}{4}$
E.S.F.S.W.R. SALVAGE HAWSER	9	6 × 37 or 6 × 61	No speci- fied length	790.0	250.0	9
E.S.F.S.W.R. TINNED FOR BOAT HOISTS	4	6 × 61	150	157.0	58.0	4
	$4\frac{1}{8}$	6 × 61	150	202.0	73.0	$4\frac{1}{8}$
	$5\frac{1}{8}$	6 × 61	150	197.0	108.0	$5\frac{1}{8}$

CHAPTER VI

Rigging

MISCELLANEOUS

Rigging Warrant

WHEN one of H.M. ships first commissions she is issued with a *Rigging Warrant* by the yard at which she was fitted out. In the warrant are detailed all the items of standing and running rigging with which the ship is fitted and the materials of which each item is made up, and thus any item can be refitted or replaced on board by the ship's staff provided that the work is within the capabilities of the staff and the materials and fittings are available. In the warrant are included the rigging gear for masts, yards, gaffs, derricks, cranes, boats' davits, ammunition and torpedo davits, lifts, boat booms, sounding booms, anchor work, towing, paravanes, awnings, ladders, fenders and stages, and miscellaneous gear such as berthing hawsers, tackles, gantlines, halyards, whips, slings, bollard strops, nets, and guardrails.

Details of fitted hawsers are not included because these are Naval Store articles, but the numbers and types supplied to a ship, also the numbers and types of awnings and other canvas gear, are included in the *Boatswain's List of Spare Gear*.

Dressing Lines

A two-masted ship of the size of a cruiser is provided with three dressing lines, namely a "fore-down", a "fore-to-main", and a "main-down", each with its dressing flags permanently seized to it. Each dressing line consists of a jackstay of $1\frac{1}{4}$ -inch galvanised F.S.W.R. with a swivel at each end, and a downhaul of $1\frac{1}{2}$ -inch tarred cordage spliced to its centre; the upper ends of the fore-down and the main-down, and both ends of the fore-to-main, are tailed with whips of 2-inch tarred cordage, and the lower ends of the fore-down and main-down are shackled to eyebolts at the stem and stern respectively. The whips are rove through blocks at the mastheads and feet of the masts. A toggle is fitted to each of the whips of the fore-to-main, close to the swivels, to prevent the swivels being hauled into the swallows of the masthead blocks.

To dress ship the whips are manned on deck, and at the order "Haul away" the lines are run up simultaneously and then set up with tackles clapped on to the hauling part of their whips.

To undress ship the setting-up tackles are removed, the down-hauls are manned, and at the order "Let go" the dressing lines are let run and hauled down by the downhauls.

Guardrails

The upper guardrails of H.M. ships are usually of 2-inch F.S.W.R., and the lower rails of $1\frac{1}{2}$ -inch F.S.W.R.; in small vessels, however, these may be of $1\frac{1}{2}$ -inch and $1\frac{1}{4}$ -inch F.S.W.R. respectively. One end of each guardrail is fitted with a thimble eye and the other with a "link shoe" or "tulip"; this special ending for guardrails, which is described on page 146, is small enough to reeve

through the hole in the head of some of the guardrail stanchions, and its link takes the tongue of a special screw and slip. Both the tulip and its screw and slip are supplied in two sizes, one for the larger and one for the smaller guardrails.

The thimble eye of a guardrail is shackled to one stanchion and the screw and slip to another, the tulip being rove through the heads of the intervening stanchions and taking the tongue of the slip; the guardrail is then tautened by the screw. An alternative used in small vessels has no screw and slip; the thimble eye is secured to its stanchion by a lanyard which is rove slack, the tulip is rove as before and shackled to its stanchion, and then the guardrail is set up taut by the lanyard.

The weakest part of a guardrail is at the point where the tulip holds the wire. The fitted tulip Patt. 2078, which is used for 2-inch F.S.W.R., is designed to take a test load of one and one-eighth tons without drawing, and the Patt. 2079, used for 1½ or 1¼-inch wire, has a test load of three-quarters of a ton; both will probably draw if subjected to approximately double these loads. A proportion only of the guardrails is tested in dockyard before issue.

Rattling Down

Some ships still have ratlines, so it is still necessary to know how to rattle down shrouds. The shrouds are first set up evenly and not too taut, and care must be taken not to put turns in them as the rigging screws are set up. The sheerpole is then seized into position.

The rigger then stands on the sheerpole, bowses together the foremost and aftermost shrouds at breast height with a small line, and seizes a stout wooden batten across the shrouds at this position. He then stands on the batten, seizes another batten across the shrouds at breast height in a similar manner, and continues this operation up the shrouds, thus making a ladder for the men who are to rattle down.

One shroud is next marked at intervals of 15 inches up from the sheerpole, and the ratlines are put on at these marks; each ratline is fitted beforehand to the correct length for the position it occupies with an eye splice at both ends.

The ratlines are seized at each end to the two outer shrouds, and clove-hitched to each intervening shroud. To seize the ratline to the shroud, splice the seizing stuff to the eye of the ratline, then pass the seizing round the shroud and through the eye, then take it back round the shroud in the reverse direction and again pass it through the eye; and having repeated this process seven times finish off with a clove hitch round all parts between the eye and the shroud.

When all the ratlines are on, the battens and bowing lines are removed, and the fore and after shrouds will straighten up and tauten the ratlines as the bowing lines are unrove.

Rattling down requires a good eye; bad work is revealed by the ratlines being too slack or too taut. If the ratlines are put on too taut the forward and after shrouds will be slightly bowsed together, and a very heavy strain will thus be put on the ratlines.

Sending Down a Slung Yard

A yard must be sent down end first to enable it to be steered clear of the numerous obstructions in its wake. To send down a slung signal yard it is first

stripped as far as possible of signal halyards and all gear liable to damage, and all electrical leads and the lightning conductor, where fitted, are carefully disconnected.

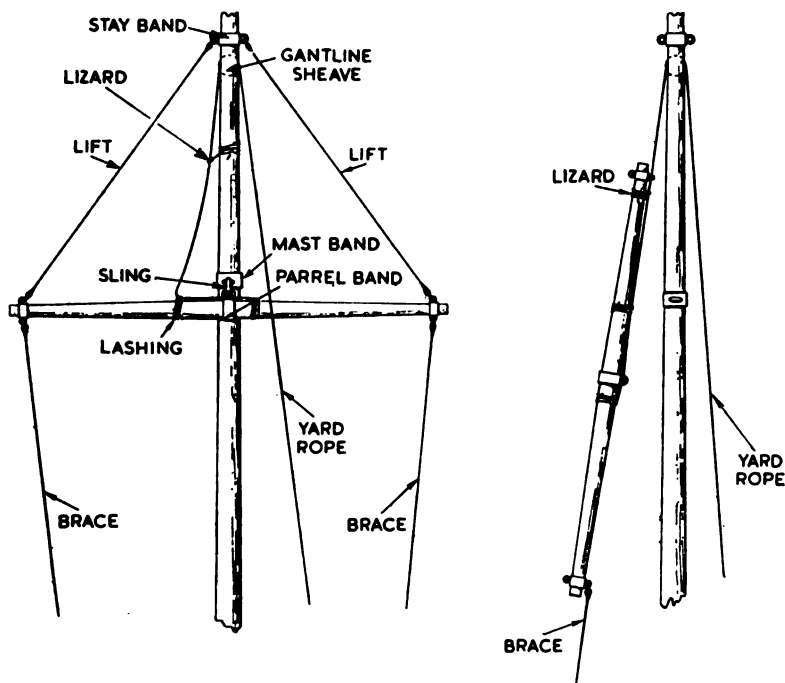


Fig. 126.—Sending down a slung yard

The yard-rope, usually a small sized wire rope, is led up the mast, over the gantline sheave at the masthead, through the eye of a lizard stopped to the masthead, and then bent to the bunt of the yard beside the parrel band; the bight of the yard-rope is then firmly lashed to the other quarter of the yard at a point a couple of feet or so from the parrel band. The foot-ropes and stirrups are stopped along the yard, and each brace is brought down to the deck where it is rove through a leading block abreast the mast on its own side.

Note.—For descriptive purposes the yard-arm nearest the quarter-lashing will now be called the upper yard-arm, and the other the lower yard-arm.

The braces are then tended, the yard-rope is manned, and, at the order "Sway away", the weight of the yard is taken by the yard-rope off the sling, which is then unshackled; while this is being done the yard is kept square by the braces.

The yard is then swayed up a foot or so while the upper brace is held fast and the lower brace is checked, thus canting the yard and slackening the lower lift, which is then cast off. The upper brace is then checked, thus allowing the yard to cant on its yard-rope until it is up-and-down. The upper lift is then cast off, the lizard is bent to the upper yard-arm, and the yard is lowered on the yard-rope, being guided on its way down by the lower brace.

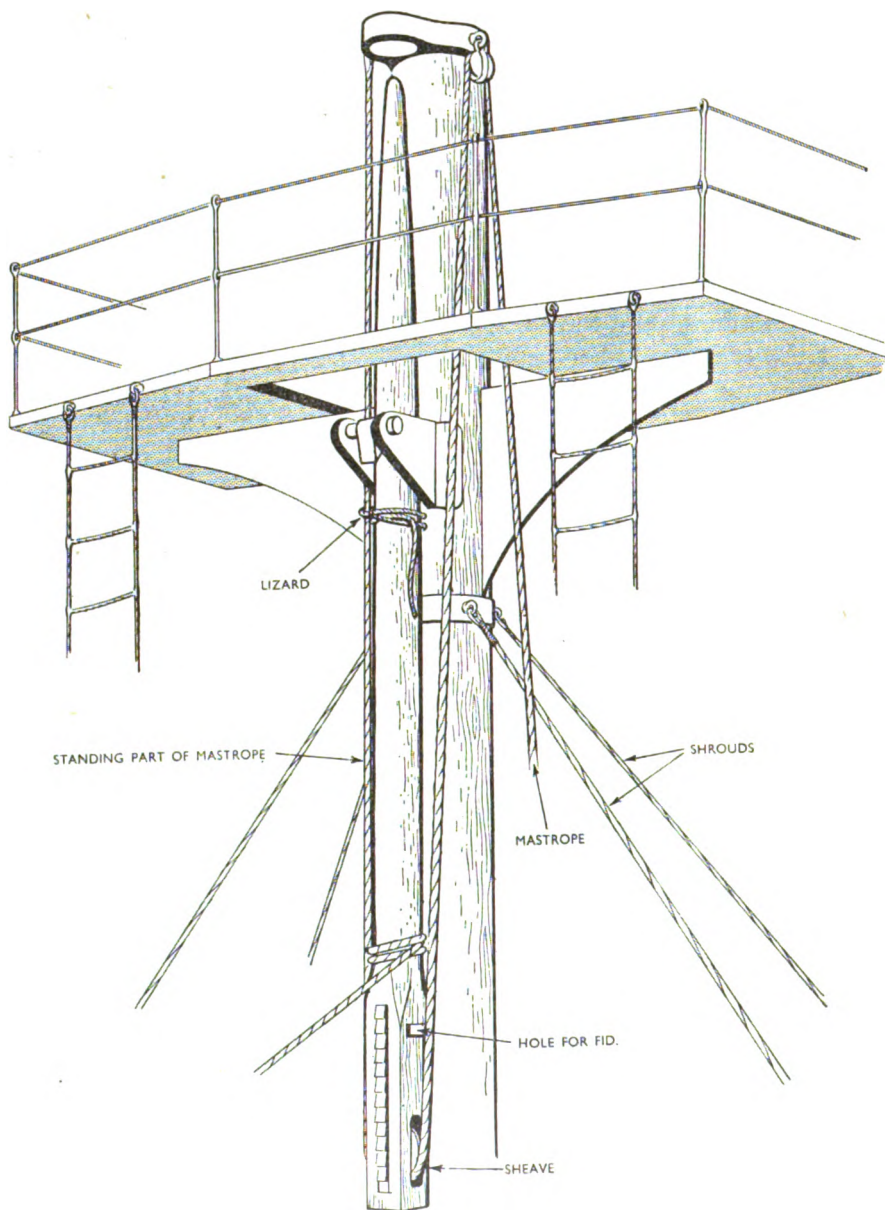


Fig. 127.—Striking a fidded topmast

Crossing a Yard to a Mast

The yard-rope is rove to the masthead through the eye of a lizard and bent to the yard in the same way as for sending the yard down, the lizard being bent to the upper yard-arm. The lifts are shackled to their respective yard-arms, then led along the yard and their ends stopped to the bunt ; the braces are shackled to their respective yard-arms and rove through their leading blocks abreast, and each side of, the mast.

The yard-rope is then manned, the braces are tended, and, at the order "Sway away", the yard is swayed aloft, on end. When the parrel band is abreast the mast band the upper lift is unstopped from the yard and shackled to the stay band, and the lower lift is unstopped from the yard and tailed with a line which is rove through the other eye of the stay band. A temporary parrel is passed loosely round the bunt of the yard and the mast, the lizard is cast off the upper yard-arm, and the quarter-lashing on the bight of the yard-rope is cast off.

The yard is then crossed to the mast by hauling on the upper brace and checking the lower brace until the yard is horizontal. The lower brace is then belayed and the yard swayed up a couple of feet or so by the yard-rope, thus canting it to enable the lower brace to be shackled to the stay band. The temporary parrel is cast off, the yard lowered until the parrel band is abreast the mast band, and the sling shackled on ; the yard is then lowered until its weight is taken on the lifts and the sling. The braces are then rove and set up, and the yard-rope is cast off the yard and unrove from the masthead.

Striking a Fidded Topmast (Fig. 127)

The mast-rope, which is fitted with a soft eye, is led up the mast, rove through a block at the masthead, through the eye of a lizard stopped to the trestle-tree, round the sheave in the heel of the topmast, and then shackled to an eye-bolt on the other side of the masthead.

The standing rigging, if led to the cross-trees and trestle-trees, is tailed with cordage to provide temporary guys, which are backed up by tackles rigged on deck to control the mast as it is lowered ; a "heel-rope" is bent to the heel of the mast to guide it down.

When all is ready the standing rigging is eased up and cast off, the guys are manned, and, at the order "Sway away", the weight of the mast is carefully taken on the mast-rope. The fid is then knocked out, the pawl thrown back, and the mast lowered by walking back handsomely on the mast-rope. The standing rigging, stay band, and any temporary guys are cast off from the masthead as they reach the lowermast top, the lizard is bent to the topmast masthead so that it is steadied by the mast-rope, and the heel is guided by the heel-rope as the mast is lowered to the deck.

To sway up the topmast the procedure is reversed ; care must be taken, however, to reeve the mast-rope the right way round the heel sheave of the topmast, or the mast will go up back to front.

Housing a Telescopic Topmast (Fig. 128)

The mast-rope is rove by a "reeving-rope" of chain or wire rope which is kept permanently rove through the heel sheave and secured on each side of the lowermast head. The end of the mast-rope is tailed to the reeving-rope, hauled round the sheave, and shackled to the eye on the lowermast.

The mast-coat and wedges are then removed, the standing rigging slacked up, the weight of the mast taken on the mast-rope, and the fid knocked out. The mast can now be housed by walking back on the mast-rope, which must be kept rove. Standing rigging is sent down on deck or stopped to the lower-mast as convenient.

To send up a telescopic topmast the procedure is reversed; when the mast-rope is unrove the reeving-rope must be tailed on to it and replaced in its original position.

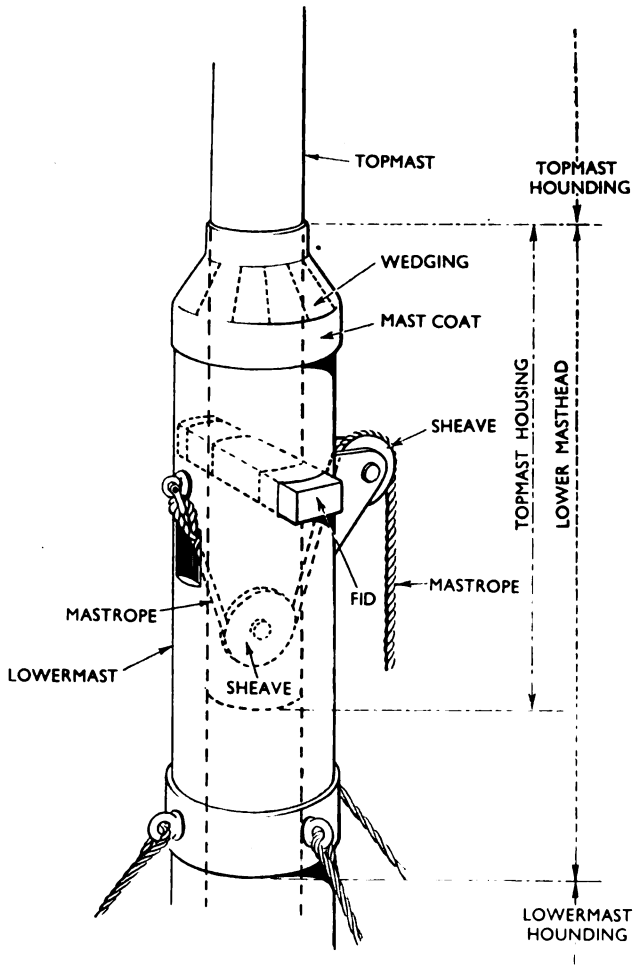


Fig. 128.—Housing a telescopic topmast

Boat Booms

The appearance of ship when at anchor can be much marred by badly rigged boat booms; they must be kept horizontal and square with the ship, and the bights of their boat-ropes should be kept clear of the water. In calm weather all boat-ropes are unrove first thing in the morning and re-rove at sunset as a matter of Fleet routine.

Correct adjustment of the topping lift is important for getting a lower boom out and in. The topping lift eye-plate is usually situated vertically above the heel fitting of the boom, and if the topping lift is adjusted so that the boom lies horizontally it will have no tendency to swing in or out, forward or aft. When, therefore, the boom is uncrutched in preparation for getting out lower booms the topping lift is adjusted to give the boom a slight droop, so that when the boom is slipped it will swing out with its own momentum and be brought up gently by its guy; the topping lift is then taken up so that the boom lies horizontally. Before the boom is got in it is cocked up slightly by its topping lift so that when hauled in its head will ride over the lip of its crutch; the topping lift is then slacked off to lower the head into the crutch.

It is not always possible, however, to place the topping lift eye-bolt vertically over the heel fitting. If outboard of the heel fitting the boom will tend to swing out with a run when slipped and be difficult to haul in because the head will rise considerably as it is hauled forward or aft and will then have to be lowered into its crutch. If the topping lift eye-bolt is inboard of the heel fitting the boom will not swing out of its own accord, and when out it will tend to come home with a run and the head will then have to be hoisted into its crutch. For such booms very careful adjustment of the topping lift is necessary to balance them and give them the correct droop for swinging out and the correct rise for hauling in.

Whenever the ship has to make an ocean passage, or if rough weather is likely to be encountered, it is a seamanlike precaution to unship the boat booms and stow them inboard when preparing for sea. Lifting eyes are usually provided, one at the heel and one at the head of the boom, to each of which is hooked a tackle led to a convenient point directly overhead. The boom is then hoisted horizontally until it is clear of the guard-rails, and then lowered on to the deck whence it can be transported to its stowage.

Ladders

The Accommodation Ladder (Fig. 129) consists of an upper and lower platform joined by a ladder. The sides of the ladder into which the steps fit are called "stringers". The upper platform is hinged to the ship's side at its inner edge, and its outer edge is supported by two steel legs, the feet of which take into lugs fitted in the ship's side. The ladder is hinged to the after edge of the upper platform, and its after end is lowered by a tackle rigged from a special davit. The lower platform is fixed to the bottom of the ladder, and when lowered in position the weight of this platform and the ladder are taken by a fitted pendant, the tackle being then removed. All the hinges have removable pins, so that the whole can easily be unshipped and dismantled.

In cruisers and larger warships the lower platform is also steadied by two legs which fit in lugs welded into the ship's side. Two sets of lugs are provided for the lower platform so that it may be at a convenient height above the water when the ship is at both deep and light load draught, and two pendants are provided for the same reason.

The draught of cargo carrying merchant ships varies much more than that of warships, so the position of the lower platform of their accommodation ladders is not fixed, and their steps are mechanically adjusted to a horizontal position by a lever and rod system.

In small ships, man-ropes are rove through the tops of ladder stanchions, but in the larger ships wooden handrails are often fitted instead of man-ropes.

In ships with a very high side the accommodation ladder is either led to a port opening on to a deck below the upper deck, as in large liners for example, or it is made in two halves. If in two halves the lower half is as already described, and the upper consists of a second ladder leading to another platform which is at the level of the upper deck. This third platform is exactly similar to the one below it, and the upper ladder is joined to both by hinges with portable pins. Such an arrangement is called a "two-throw ladder".

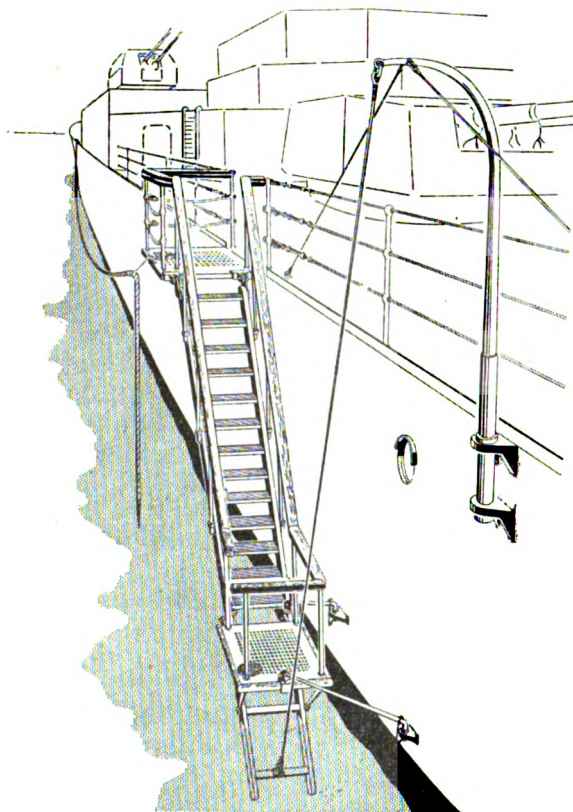


Fig. 129.—Accommodation ladder

When lying in a strong current or tidal stream it is necessary to prevent a boat which overshoots the gangway from being jammed by the current under the ladder, and if ships' boats only are concerned this can be done by rigging a simple "tide spar". This spar is laid forward from the outer stringer of the ladder to the ship's side and lashed in position, but it must not project outboard of the stringer. If the ship is moored head and stern so that she cannot swing with the tide, a similar spar must be rigged abaft the ladder to protect boats coming alongside bow to stern when the ship is stern on to the tidal stream.

When heavy harbour craft are employed as tenders a ship lying in the stream usually secures large wooden stages or "catamarans", some 12 or 15 feet long, abreast her accommodation ladder.

An accommodation ladder should not be used when there is a sea or swell high enough to render boats liable to be caught underneath the lower platform; a jumping ladder should then be used instead.

The Mediterranean Ladder is a plain wooden ladder hinged at its upper end and lies against the ship's side. Its great disadvantage is that boats coming alongside with too much way on may cant it by rubbing against its lower part and thus break or strain the stringers or the hinges. To strengthen it guys can be fitted to the lower end, or the lower end can be shipped in lugs welded to the ship's side. This ladder is often of somewhat flimsy construction, but if strongly made and well guyed it can be very serviceable under most weather conditions.

The Jumping Ladder (Fig. 130) is portable and can be hung over the side of a ship at sea where most convenient to embark anyone from a boat. It consists of two pairs of side-ropes made of chain, wire, or cordage, which are rove through and support each end of a series of wooden treads; it should reach from the gunwale or the top of the bulwarks to just above the gunwale of the boat.

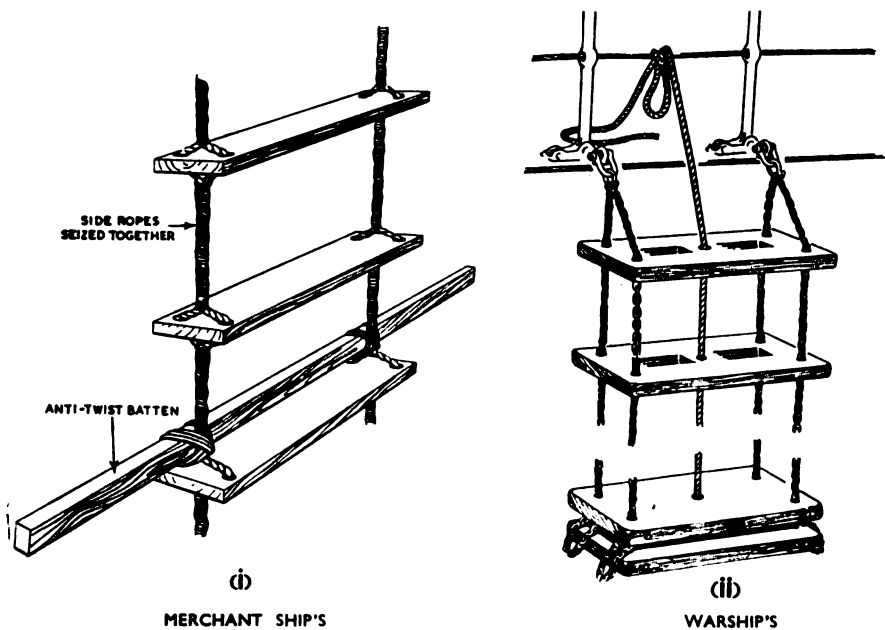


Fig. 130.—Jumping ladders

The treads, usually about 1 ft. 9 in. long, 6 in. broad and $1\frac{1}{4}$ in. thick, are spaced at intervals of about 9 inches, and they should be so fitted in the side-ropes that they are horizontal, both fore-and-aft and athwartships, and are prevented from twisting. The top of the ladder should be secured inboard by lanyards or shackles to ring bolts or to some other permanent fitting, and never to guardrails. In ships with a high freeboard the ladder should be kept from twisting by 4-ft. battens lashed across the lower half of the ladder at about 10-ft. intervals. These ladders are not usually provided with man-ropes because the climber should grasp the side-ropes or the handholes cut in the treads, but in a seaway a life-line should always be bent round the climber and tended on deck.

Fig. 130(i) shows the construction of a type of jumping ladder used in merchant ships. It has two pairs of wire or cordage side-ropes, each pair being

married and seized together between the treads and as close as possible to them to ensure that they are kept square and as rigid as possible.

Fig. 130(ii) shows a type of telescopic jumping ladder provided in warships. The two pairs of side-ropes are of $\frac{1}{4}$ -inch rigging chain, fitted with long links where the chain passes through the treads. Each tread is drilled athwartships, near each end, with a hole through which is passed a clenched pin which also passes through the long link, thus securing the tread to the side-ropes. A hole is drilled through the centre of each tread, and through this hole is rove a lanyard the lower end of which is fitted with a Turk's head to prevent it unreeving; by means of this lanyard the height of the ladder above water level can be adjusted by tricing up the lower treads, and with it the ladder can be triced up compactly for hoisting inboard. Each of the Canadian-elm treads, except the bottom three, are cut with two handholes.

The Sea Gangway consists of permanently fitted horizontal wooden strips projecting for about three or four inches from the ship's side so as to form the treads of a ladder, and to make it ready for use it is only necessary to rig man-ropes. Though not fitted in modern ships it afforded a practical and effective means of getting aboard in bad weather.

GANGWAY AND LADDER GEAR (see Fig. 129)

The following gear is also used in connection with ladders and gangways:—

- (i) *Gangway Boat-ropes*.—The gangway boat-ropes can be of the greatest assistance to a boat coming alongside in a rough sea or a tideway, but it is useless unless led well forward so that it lies nearly in the fore-and-aft line of the boat when she is alongside.

A length of smaller rope, known as a "stray line", which is spliced into the boat-rope about a fathom from its after end and belayed to a cleat on the upper platform, is used for tricing up the boat-rope when not in use, the end of the boat-rope being then cheesed down on the platform. It is the duty of the gangway staff to lower the boat-rope to each boat as she comes alongside, so that her bowman can belay it forward in the boat; but care must be taken that the weight of the boat is taken by the boat-rope and not the stray line.

When a ship is secured head and stern to buoys in a tideway a second boat-rope should be rigged abaft the ladder for the use of boats coming alongside bow to stern to head the tidal stream.

- (ii) *The Check Line*.—This is a small length of line spliced round one of the stanchions of the lower platform of the accommodation ladder, and is used by pulling and sailing boats for checking their way when coming alongside. When a boat approaches, the side boy should be at the bottom of the ladder to pass the check line to her, and the line requires careful watching because if washed off the platform it may be caught in the propeller of a power boat.

Fenders

Fenders are used to protect the side of a ship when going alongside a jetty or another ship, by absorbing and distributing the shock of any impact; they are also used to keep a ship which is lying alongside at a safe distance from the jetty or the other ship. The spring or give in a fender absorbs the shock, and its bearing surface distributes it over the hull of the ship. The less the shock

is absorbed and the weaker the hull of the ship the wider must be the area over which the shock is distributed. Misuse of fenders can cause much unnecessary damage, particularly to lightly built ships.

For boats, and other small craft whose sides are strong in comparison with the weight of the vessel, fendering presents no difficulty and any of the soft types of fender are adequate.

For larger vessels, especially lightly built craft such as destroyers, fendering is less simple. The fender must be sufficiently robust to withstand the crushing to which it is subjected by the weight of the ship, and it must be large enough to spread the shock over the comparatively weak hull plating ; in addition, it must be wide enough to prevent projections from the ship's side fouling the adjacent jetty or vessel. A fender that meets all these requirements is, however, usually too heavy to handle on board ship, so a compromise has to be struck between handiness and efficiency, and a sufficient number of fenders must be used to distribute the shock widely.

Fenders should be placed where the hull of the vessel can best withstand impact ; to some extent this is applicable to all vessels, but in destroyers and other lightly built craft it is essential. In destroyers the fenders must be placed so as to spread the shock over at least three frames, and the more the better ; if this is impossible they must be placed abreast a bulkhead, or abreast the gunwale or a deck edge, where the ship's side is at its strongest.

Of the many different types of fenders in use those commonly supplied to the Royal Navy are described below. Provided that the foregoing principles of fendering are observed, the best method of using them is largely a matter of common sense.

The Coir Fender is a soft fender of pudding or sausage shape, and is supplied in various sizes. It consists of a centre of soft packing sewn up in a hessian bag and enclosed in one of the standard coverings, such as the Turk's head, half-hitching, or continuous walling, worked in coir ; their lanyards are of tarred sisal. Where increased volume is required three can be lashed together in clover-leaf fashion. These fenders should not be allowed to become water-logged, because they then become very heavy and clumsy to handle.

The Apple Ring Fender is made of lengths of junk cheesed down, one on the top of another, to form a ring which is lashed round with ring-bolt hitching. This is a very useful fender, being more durable and less liable to roll than the pudding and yet springy. They are often used on the sides of tugs.

The Destroyer Fender is a long light channel-shaped length of wood, with a lanyard at each end, and is intended for use horizontally between two destroyers because owing to its length it spreads the shock over several frames. It is usually placed opposite that of the other ship, and a number of coir fenders are then sandwiched in between them ; this combination makes an efficient fender, and though not very robust it will stand up to a certain amount of bumping if carefully tended and plenty of coir fenders are used.

The Catamaran is a stoutly constructed rectangular wooden raft and is generally the most satisfactory fender for use between two ships. As it is not resilient, it should be sufficiently long to spread the shock. Unless a catamaran has sufficient depth it is liable to be turned on edge by the movement of the ships, this being more likely with a light catamaran than with a heavy one ; a good rule for a light catamaran to be made and carried on board is that the depth should be not less than one-third of the width. Some ships use small,

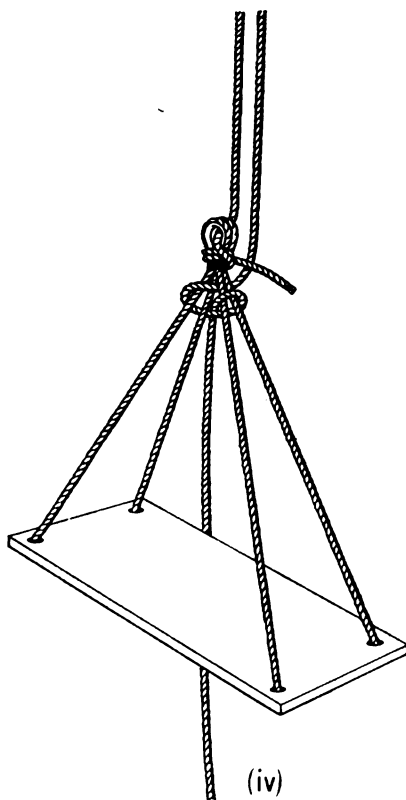
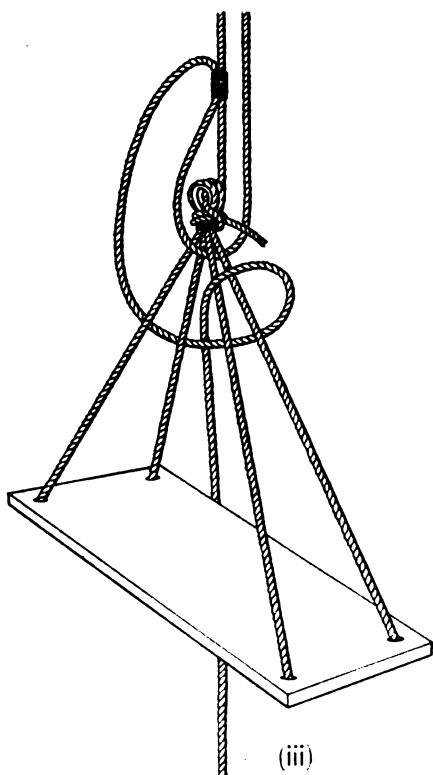
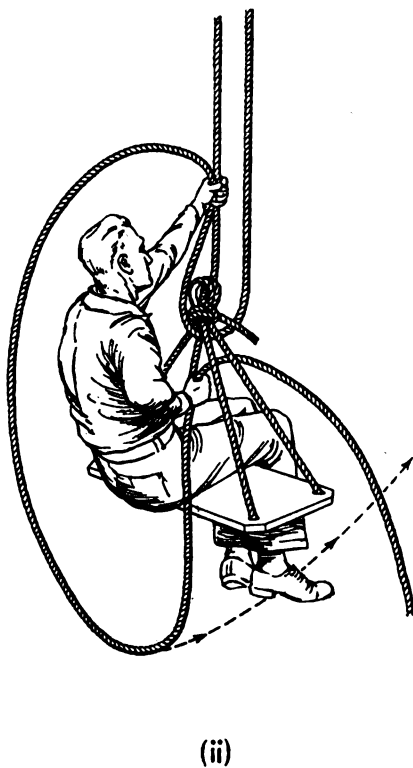
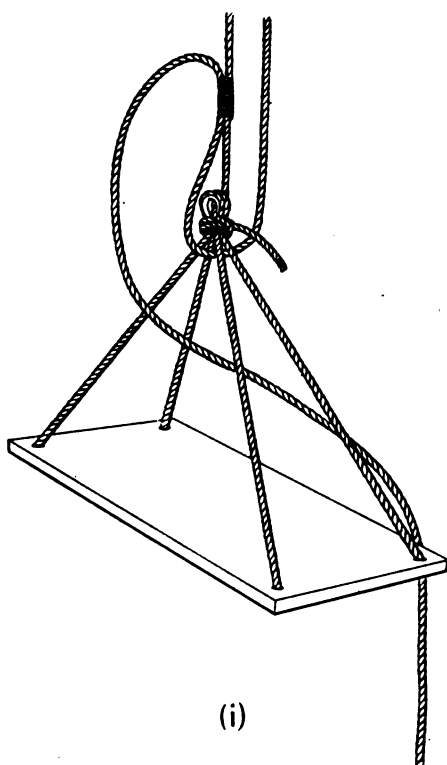


Fig. 131.—Lowering hitch used with bosun's chair on a gantline

wide, catamarans to keep harbour craft from rubbing the paint off their sides, and these need not be made so deep as they are only used for fending off light craft and are therefore not so liable to turn over.

The Hazel-rod Fender consists of a bundle of hazel-rods, bound with wire rope round a wire rope core and with a thimble eye spliced into each end, and there is a small wood or metal disc about four inches in diameter round each splice. These fenders have considerable spring and stand up well to crushing when used between destroyers, but if used for larger ships they tend to break up. When used on a destroyer's side they must be slung horizontally, otherwise they will not spread the shock across her frames, but they are usually slung up-and-down abreast the after end of her forecastle deck to protect the gunwale.

The Celerol Fender consists of a hazel-rod fender passed through the centre of a number of old motor tyres and then slung horizontally; it is efficient but is of course heavier than a plain hazel-rod fender; as in all fenders embodying motor tyres the tyres should be pierced to allow water to drain from them.

The Bramble-leaf Fender consists of a spar served with junk and passed through a number of old motor tyres, a wire lanyard being shackled to each end so that it can be slung horizontally. It is more durable than the Celerol fender, but very heavy unless the spar is of balsa-wood. A 3-ft. long Bramble-leaf fender is useful for protecting the Mediterranean ladder from lighters and other harbour craft.

The Roller Fender also affords suitable protection against harbour craft. It consists of a number of wooden battens, about 3 in. by 3 in. and 2 ft. 8 in. long, rove Jacob's ladder fashion on three $\frac{1}{2}$ -in. wire ropes, the battens being some 3 in. to 6 in. apart; the whole is then rolled round a 3-ft. spar of 6 in. diameter, to the ends of which wire lanyards are shackled.

The Spar Fender consists of a baulk of timber, such as an old pile or the trunk of a tree, fitted with a swivel and lanyard at each end. They are chiefly used to fend a ship off a jetty or pier.

Stages

Plank Stages, suspended by rope lanyards at each end, are used to support men when washing and painting the ship's side and superstructures. The lanyards are secured to a small cross piece of wood, called a "horn", at each end of the stage; these project from the stage and so keep it at a convenient distance from the ship's side.

A long soft eye is either spliced or made with a bowline in one end of each lanyard and then placed under the end of the stage with a half hitch taken round each horn, as shown in Fig. 132. The lanyard is then passed round a cleat or stanchion near the gunwale above, or through the eye of a lizard rigged for the purpose, and the end is then brought down and belayed

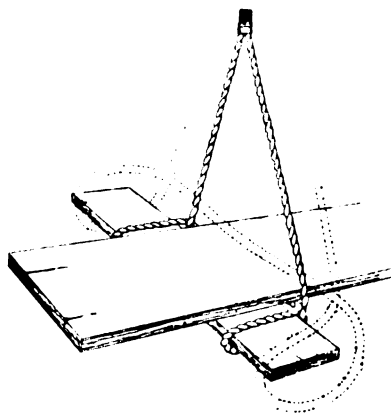


Fig. 132.—Securing a lanyard to the end of a plank stage

round the horns of the stage, thus enabling those working on the stage to lower it themselves to the position required. The lanyard should never be rove round a guardrail. When a lizard is used its tail is belayed round a secure fitting on the deck above the stage so that the eye hangs clear of all obstructions, thus giving a clear lead for the lanyard and avoiding chafe.

Bosun's Chair on a Gantline—A seaman using a bosun's chair on a gantline (e.g. when painting down aloft) must be able to lower himself as he works, and three methods by which he can do this are described below.

- (i) By bending the hauling part of the gantline with a sheet bend on to an eye seized into the sling of the bosun's chair, which is a simple and secure method.
- (ii) By means of what is known as a "lowering hitch". This method is extensively used in the Merchant Navy and is easier to work than the sheet bend method, but care is necessary in making it. When the chair has been hoisted high enough a bight of the hauling part of the gantline is pulled through the sling of the chair and racked to the running part; this holds the weight of the chair safely while the hitch is made (Fig. 131(i)). The man on the chair then hauls up more of the bight, passes it over and behind him (Fig. 131(ii)), dips it under his feet, and brings it up to form a half hitch round the parts of the slings on one side of him (Fig. 131(iii)). The racking can now be cut, but the weight must be held as the hitch is settled into position at the top of the sling (Fig. 131(iv)); it is then quite secure and the chair can be lowered by hauling up some slack and rendering the turns, which is quite easily done.

A seaman who is thoroughly accustomed to making this hitch can dispense with the racking and hold the parts with his hand, as shown in Fig. 131(ii), but as a mistake on his part may involve him in an accident this should never be attempted by a novice.

- (iii) A large hook is secured just above the sling of the bosun's chair to the running part of the gantline. The bight of the hauling part is then brought up through the sling and placed over the hook, a second bight is brought up outside the sling and also placed over the hook, and a third bight can be passed if necessary. The stage can then be lowered as shown in Fig. 133.

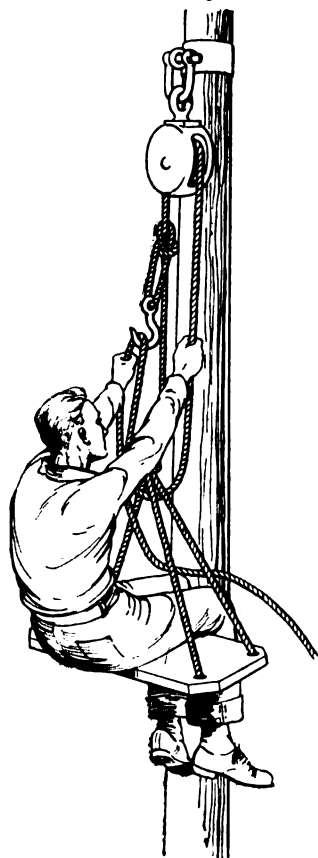


Fig. 133.—Use of a hook for lowering bosun's chair on a gantline

Bosun's Chair on a Stay.—To enable a seaman to ride down the length of a stay, when blacking down the rigging for example, the chair is slung from a large shackle placed on the stay and a gantline is made fast either to the sling or to the shackle ; it is important that the crown of the shackle and not the bolt should bear on the stay, otherwise the bolt may be revolved and come out as it rides down the stay. The chair can be manoeuvred past any obstruction on the stay, such as an insulator, by putting a second shackle on the stay below the obstruction and then transferring the weight of the chair and man to it, the original shackle being then removed and lowering continued.

Stages on Funnels.—In cruisers and larger warships a set of special chain gantlines is provided for rigging stages on the funnels. Funnel chains, if fitted, are unrigged when not in use as they are noisy at sea and damage the paintwork. It should be possible to rig stages without having to let fires in the boilers die out, and, if other means of reeving the first gantline are not available, it will be necessary to keep one permanently rove with small wire rope. Once the first gantline has been rove the remainder present no difficulty, each being rigged from a bosun's chair sent up on its neighbour.

Repairing a Spar

Temporary Repair.—A broken spar can be repaired temporarily by " fishing " it, which consists of lashing one or more spars along the broken one, as when making a splint. The correct method of fishing a broken spar is described below, and if thus fished it will be strong but rigid ; the description given is, however, intended to be followed in principle only, as details of an emergency repair must necessarily depend upon the circumstances and upon the gear available.

The broken ends of the spar are lined up carefully and married as closely as possible, usually with the aid of a maul, and are sometimes held in place by small pieces of wood or metal nailed across the join. The " fishing " spars,

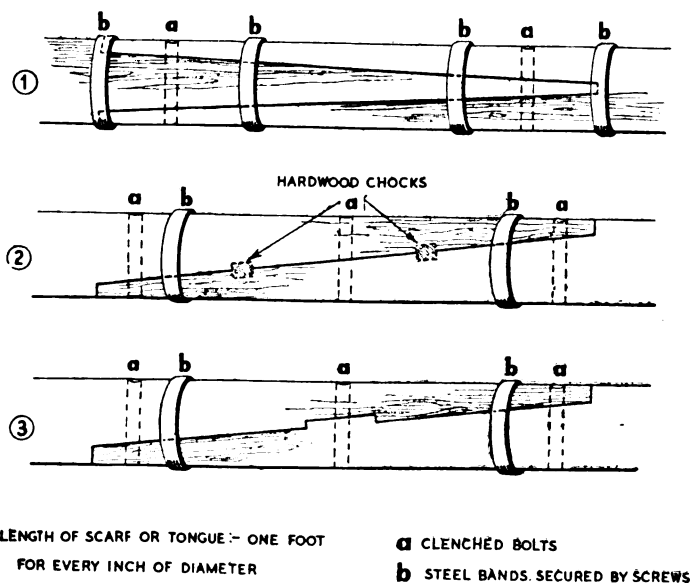


Fig. 134.—Methods of scarfing a broken spar

which can consist of lengths of any suitable material such as 3 in. by 3 in. quartering, are spaced equidistantly around the break and lashed temporarily in place; their length should be not less than nine times the diameter of the broken spar, and they should lie closely to it throughout this length, small wedges or strips of wood being used as packing where necessary if the spar is of an awkward shape. In addition, any space between the spars must be filled in, usually with odd lengths of wood, to prevent them from slipping sideways beneath the lashing. The full length of the fishing is then tightly bound with a wire rope lashing put on as for a serving or a common whipping, and should the wedges beneath the temporary lashing tend to slack up they must be kept driven home as the binding proceeds. The temporary lashing is removed, piece by piece, as it is reached by the permanent binding.

Permanent Repair.—A permanent repair, which is flexible, can be achieved by “scarfing”, but this involves some shortening of the spar. Scarfing is a shipwright’s job, the principles of which are shown in Fig. 134.

AWNINGS

All awnings are carefully cut and made up to fit the position over which they are to be spread, and every care should be taken to preserve their shape. A baggy, wrinkled, or torn awning is usually the result of maltreatment, and being conspicuous when spread it may then seriously mar the appearance of an otherwise well kept ship.

In general, awnings can be divided into two types: large tented awnings such as forecastle and quarterdeck awnings, and small flat awnings such as wing, waist and bridge awnings.

Small Awnings

A small awning is of No. 4 R.N. canvas and made up from a number of strips or panels, called “cloths”, which always run athwartships in the completed awning. The cloths are sewn together to the size and shape of the awning, care being taken that any “butts” (joins) in individual cloths are staggered along the length of the awning.

The awning is strengthened by a bolt-rope of cordage, which runs continuously round its edges and helps it to retain its shape. The bolt-rope is always secured to the underside of the edge of the awning so that when folded it can be opened and laid out the right way up for spreading. Cringles are worked into each clew, and at intervals along the sides, to enable the awning to be hauled out by its earrings to the points between which it is spread. Laced openings, called “shark’s mouths” are provided wherever the awning has to be fitted round rigging or ladders.

Where one awning butts against another it is provided with a flap, called an “apron”, which bridges the gap between the two and is laced to a narrower flap, called a “frog”, on the second awning. The apron also serves as a cover to protect the awning when it is rolled up for stowage, and, as the awning stops are provided at this end, the awning should always be made up towards its apron.

A bridge awning is usually lashed at its clews to four brass awning stanchions, and its sides are laced to a copper wire rope jackstay called a “ridge-rope”, rove between the heads of the stanchions; brass and copper are used as they will not affect the magnetic compass. A wing or a waist awning is

usually lashed at its inner clews to eye bolts in the superstructure, and at its outer clews to the heads of awning stanchions; its inner side is usually hooked to a standing "awning rail" on the superstructure, and its outer side is laced to a ridge-rope running between the heads of the awning stanchions.

An iron bar called a "strongback" is sometimes fitted as a support between the end stanchions of an awning and the superstructure, and the fore and after sides of the awning may also be laced to these strongbacks. Along the edges which are thus secured to standing rails or strongbacks the awning is reinforced by an extra layer of canvas, which is about ten inches wide and called a "doubling piece"; the outer edge is not so strengthened. Small doubling pieces are also fitted in the wake of clews and cringles, and, wherever chafe may occur, the awning is protected by leather "chafing pieces".

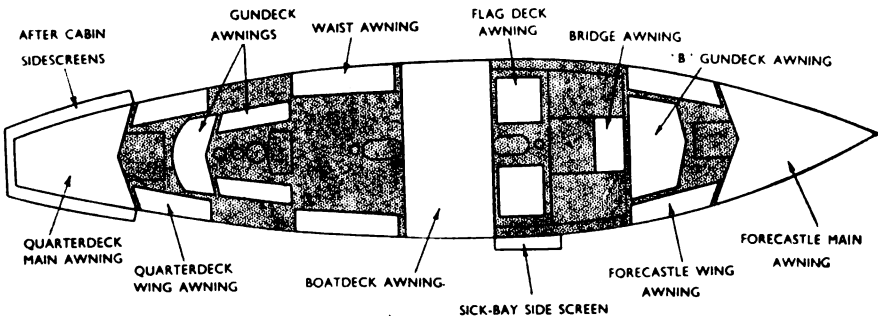


Fig. 135.—Examples of a ship's awnings

Tented Awnings

Quarterdeck and forecastle awnings are tented and differ in make-up and rig from the smaller awnings; they are made from No. 2 R.N. canvas, with their cloths always running athwartships. In all but the smaller sizes the bolt-ropes along the outer edges are of flexible steel wire rope which is served over before being marled to the awning; the bolt-ropes at the remaining edges are of cordage. These awnings are spread over a centre-line ridge-rope of canvassed flexible steel wire rope, which runs from the jack staff or ensign staff supports to an eyeplate or stanchion on the fore or after turret, or to an eyeplate on the superstructure; one end of the ridge-rope is provided with a screw slip to enable it to be set up taut.

The awning is strengthened with doubling pieces and extra layers of canvas are sewn along its centre-line to take the chafe of the ridge-rope, leather chafing pieces being fitted in the wake of the ridge-rope slips. The awning stops are sewn along the top of the centre-line.

At one end of the centre-line is a large cringle which is shackled or hooked to a fixed point on the superstructure or turret, or to a special stanchion, and the other end is hauled out by means of a wire pendant and tackle rove on the ensign staff or jackstaff support. The sides of the awning are hauled out to stanchions on each side by special earrings consisting of chain or wire pendants tailed with cordage (Fig. 136). These earrings can either be hooked or shackled to the cringles and then led through a roller shackle at the head of the awning stanchion and belayed to a cleat at its foot; or they can be shackled to the head of the awning stanchion and then led through a shackle in the cringle and back through the roller shackle to the cleat. Awning tackles are provided to

assist in spreading the awnings and setting them up ; their upper blocks are hooked to eyes in the lower ends of the earrings and their lower blocks are hooked to eyebolts in the deck at the feet of the awning stanchions.

One end of a tented awning is cut to fit exactly at certain "fixed points" ; in a forecandle awning these are at the after end and in a quarterdeck awning they are at the fore end, and any subsequent stretch in the awning is allowed for by cutting the remainder slightly smaller than the area it is designed to cover. Whenever an awning is spread this fitted end should be secured first to its "fixed points" and the remainder then be hauled out to its other anchorages, otherwise it will eventually become distorted and appear bagged and shapeless when spread.

Some tented awnings are fitted with cordage bolt-ropes, and their sides are usually laced to ridge-ropes rove through the heads of the awning stanchions.

A tented awning may have its centre-line ridge-rope sewn into it, this ridge rope being then known as the "backbone".

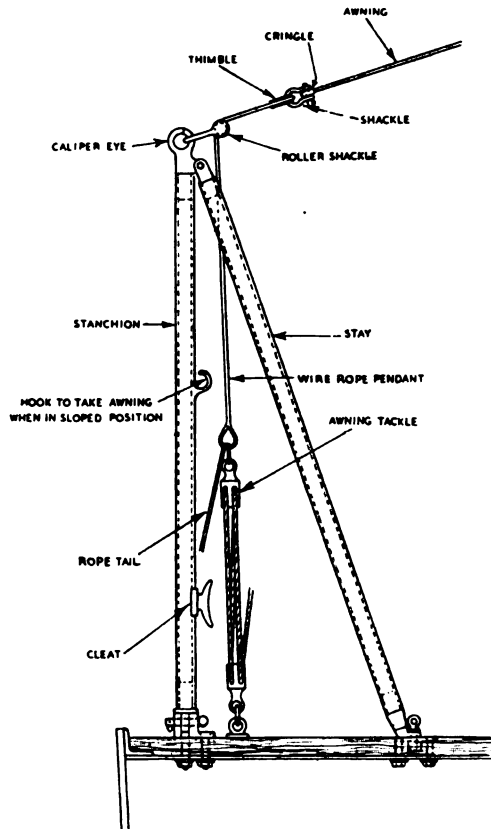


Fig. 136.—Awning stanchion

Flagships and some other large warships are supplied with a ceremonial awning, made of bunting, in which alternate cloths are red and white. It is spread beneath the quarterdeck awning on ceremonial and state occasions, and for dances and other occasions of entertaining guests.

Ships serving in very hot climates are supplied with double awnings rigged one above the other with an air space in between.

Awning Curtains and Gable Ends

Awning curtains, made of No. 6 R.N. canvas, are provided to screen and shelter the quarterdeck. They are fitted at intervals with eyelets at the bottom and sides, so that they can be laced together and hung by stops from a line sewn along the edge of the awning just on the inner side of the bolt-rope. The bottom of each curtain is stopped either to the lower guardrail or to eyebolts in the deck, and gaskets are sewn along the top edge to enable them to be rolled up and stopped in place. The quarter deck can be further screened in by a "gable end", which runs athwartships and is stopped to a line sewn across the underside of the awning; the bottom of the gable end is weighted to keep it in place, and one or two flapped entrances are cut in it.

Side Screens

Side screens, made from No. 6 R.N. canvas, are supplied to shade the ship's side from the sun in hot weather, and are spread over boomkins projecting at right angles from the ship's side. The boomkins are heeled with goosenecks and shipped in sockets at deck level. The inner edge of the screen is laced to a guardrail, and the outer edge has eyelets or becketts which fit over a

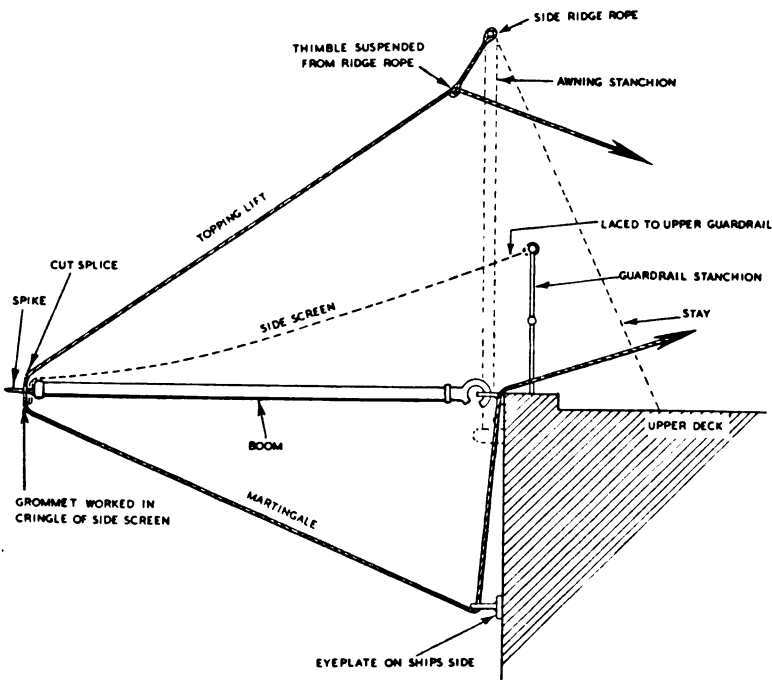


Fig. 137.—Rigging a side screen

spike in the head of each boomkin. Each boomkin is fitted with a combined topping lift and martingale, which is rove over the head of the boomkin by means of a cut-splice, then through an eye lower down on the ship's side, and then back to deck level. The foremost boomkin is provided with a fore guy,

and the after one with an after guy, the remainder being held in place by the screen itself.

To spread a side screen the inner edge is first secured to the appropriate guardrail ; the boomkins are then held vertically with their heels shipped in position, and the outer edge of the screen is hooked over the spikes and the martingales are rove ; finally the boomkins are lowered together and all the gear is set up taut. Side screens require careful attention to keep the boomkins horizontal and square to the ship's side.

Spreading Awnings

A small awning such as a bridge, wing, or waist awning, should first be lashed by the earrings on its windward clews, and then unfurled to leeward and its leeward clews secured. The clew earrings can then be hauled taut, and the sides hooked or laced to the ridge-ropes or awning rails.

A large awning needs more care and the method of spreading a quarterdeck awning is given here as a guide, but it is first necessary to know how an awning is folded for stowage. Before stowing an awning it is spread on the deck with its upper side down and the two sides are then folded to the centre-line and squared off. The two doubled sides are then rolled towards one another to meet at the centre-line and whole is then secured by the stops fitted along the top of the centre-line. The earrings and awning tackles are always detached and stowed separately, but the lacings of a small awning can be made up with it.

When spreading a quarterdeck or other tented awning in a cross wind it should always be passed over the ridge-rope from the leeward to the windward side ; if passed over from the windward side the pressure of the wind on its sloping surface up to the ridge-rope will make it very difficult to haul it over the ridge-rope to the lee side.

Before spreading a quarterdeck awning it is laid along the deck with its stops uppermost, the stops are then cast off and each side unrolled, and the bolt-rope on each side is then hauled clear to the leeward side of the deck. The leeward earrings are then secured to their cringles, which are rove slack through their roller shackles and belayed to their cleats. Then hauling-over lines are bent to the windward cringles and passed over the ridge-rope to the other side, where they are manned.

With heavy awnings, or in a high wind, the awning tackles on the windward side can be clapped on to the hauling-over lines and used to assist in hauling the awning over the ridge-rope ; these tackles are also useful for anchoring the weather edge to the far side and for holding it down while the earrings are being secured and rove. Similarly, the leeward awning tackles can be hooked direct to the lee cringles and set up to ensure that the wind does not blow up under the lee side of the awning. With heavy awnings it is also usual to rig " tent lines " over the ridge-rope, from the feet of the leeward awning stanchions to the feet of the opposite windward awning stanchions, to support and guide the awning as it is hauled over.

At the order " Haul over " the awning is hauled over the ridge-rope to the other side and the fore end of the awning is secured to its " fixed points ". The earrings are then shackled on and rove, and the awning tackles are hooked on and manned. The after clew is hauled aft by its earring tackle, thus tautening the centre-line of the awning ; then the side earrings are hauled out together, care being taken to keep the centre of the awning in line with the ridge-rope.

When the awning is correctly spread the awning tackles may be unhooked and stowed away.

Care of Spread Awnings

The cloths of a new awning will eventually stretch lengthways by approximately one inch in every foot, but they will not increase appreciably in breadth; a new awning will therefore stretch considerably athwartships but scarcely at all in a fore-and-aft direction, and this is allowed for when the awning is first cut to shape. If a good spread is finally to be obtained the stretching must be done gently and gradually. A new awning must therefore never be hauled out or kept too taut until it has been fully stretched, and this stretching must be done by hauling it out a little more each day.

Canvas, like cordage, shrinks when wet, but it should regain its shape when dry if meanwhile it has not been overstretched. A fully stretched awning has little elasticity and may easily be ruined by overstretching when damp or wet. Earrings should be eased off in damp weather, and always at night on account of dew. Awnings should not be fully spread until they are dry, and for this reason they are seldom fully re-spread during the morning watch.

Sloping Awnings.—When it is raining awnings should be “sloped”. This is done by shifting each alternate earring from the head of its stanchion to a special hook fitted for it lower down on the stanchion, and unshackling the remaining cringles from their earrings and hooking them directly to their awning tackles, by which the awning is then bowsed down. This should prevent pools of rainwater or snow from collecting on the top of the awning and forcing it out of shape, but if the rain or snow is so heavy that sloping the awning is ineffective it should be furled.

Frapping an Awning.—If caught unawares or short-handed by a sudden squall a tented awning should be fully sloped and “frapping lines” rove. These lines, of strong cordage, 3-in. or 4-in. manila, are rove athwartships over the awning and belayed at each side on deck so that they help to keep the awning from billowing and slatting. To rig frapping lines overnight as a matter of routine is a slack habit, and should be discouraged because even in light winds their chafe will soon wear holes in the awning; they should be rigged only when a sudden blow is possible, but better still is to furl the awning overnight. If frapping lines are rigged hauling-over lines should also be rigged, and tent-lines, if used, should be rove and stopped to the heads of the awning stanchions and all gear be prepared for furling.

Furling Awnings

A large awning, if well fitted, fairly flat and tautly spread, will stand up to winds of about force 5 Beaufort scale, but in stronger winds they are liable to slat badly and may then carry away. Small flat awnings such as bridge awnings should stand up to winds of force 6 quite comfortably. All awnings should be furled well before the danger point is reached, and it is best always to furl them when in doubt rather than have them suddenly blown away.

An awning is usually furled to windward and the procedure is the reverse of that with which it was spread. With a quarterdeck awning, tent lines and hauling-over lines are rigged, earrings are eased away squarely and evenly, and the earring tackle at the after end of the centre-line is eased off. The lee earrings are unrove and manned; the weather earrings are unrove, and if the

wind is strong the weather awning tackles are hooked into the weather cringles and belayed. The after clew is eased forward on its earring ; the fore end of the awning is cast off and then, at the order " Haul over ", the lee side is hauled over the ridge-rope.

As the lee side is hauled over the weather side is hauled across the deck to the lee side, so that the awning is eventually laid out underside uppermost and ready for making-up. When furling an awning in a strong wind care must be taken that the wind does not get under the awning and blow it overboard.

In a short-handed ship when it comes on to blow hard the quarterdeck awning may be safely furled to leeward under frapping lines in the following manner. The awning is fully sloped with the awning tackles secured to the cringles, and a large tackle is then shackled to the fore weather clew and belayed. The after clew is let go from its earring and gathered, and the awning is passed over progressively from aft forward, each part being gathered as it comes to hand. Eventually, all hands are available to hold and gather the windward clew as it is eased over by its tackle.

Maintenance of Awnings

An awning, or for that matter any canvas gear, should never be stowed below wet as then it will not only quickly rot but be very liable to catch fire from spontaneous combustion. (The danger from spontaneous combustion is much greater in the case of painted canvas, which for this reason is always stowed in a special store.) A wet awning should be temporarily stowed in a sheltered place on deck until an opportunity occurs for drying it, and the quickest way of drying it is to spread it in good weather.

An awning should always be lifted and carried, never dragged along the deck, and, if necessary to lay it down on deck, it should be laid on battens, capstan bars, or gratings, to keep it clear of the deck and any dirt. As awnings are spoilt by frequent scrubbing every care should be taken to keep them clean ; decks should be swept before spreading or furling them, and when made up awnings should be stowed where they are protected from dirt and damage. Bags or covers are provided for side screens, gable ends, and ceremonial awnings, and they should be stowed in them when not in use.

SAILMAKING

Canvas

Royal Navy (R.N.) and Merchant Navy (M.N.) canvas are made of flax, or sometimes of flax and hemp, and they are supplied in rolls 2 feet wide and 39 yards long, called " bolts ".

The formation of a length of canvas is shown in Fig. 138. The threads which run across the breadth of the canvas are called the " weft ", and those which run throughout its length and are rove alternately over and under the threads of the weft are called the " warp ". As the weft is continuous and unbroken the canvas does not fray at the " selvages " (sides of each strip) ; but it will fray at the ends of each strip and wherever it may be cut, and such an edge is known as a " raw edge " and is never permitted in sailmaking, either when sewing canvas or in the completed job. If a raw edge is to be sewn it is first folded over to a depth of about half an inch and the stitches are made along this fold, it being then known as a " false selvage ".

Canvas will stretch to a limited extent lengthways in the direction of the warp, but not appreciably in the direction of the weft, and if a heavy pull is exerted along the warp the breadth of the canvas will be slightly reduced.

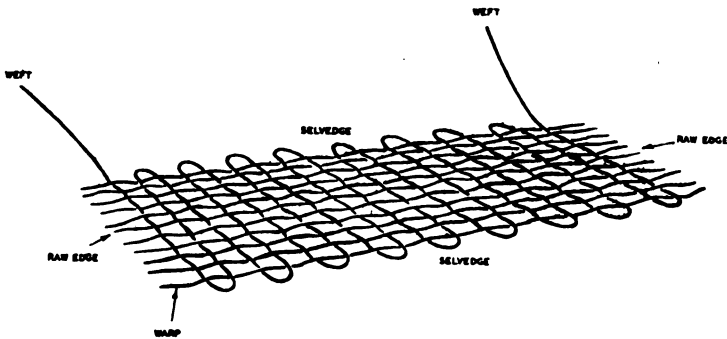


Fig. 138.—Diagram showing construction of canvas

When wet the threads themselves shrink, those of the warp shrinking rather more than those of the weft, and they will not resume their original length when dry unless the canvas is again stretched out taut. Allowance is made for the initial stretch in canvas when cutting out a new awning, and shrinkage is also allowed for when making unpainted canvas covers for reels and other fittings.

When canvas is painted the paint fills in the spaces between the threads, and when dry it prevents either shrinking or stretching, but as the paint is applied the canvas will shrink slightly. When a very taut screen is required the canvas is laced in place as tautly as possible, then wetted to tauten it still more, and painted whilst still damp.

Canvas for the Royal Navy is manufactured in different weights, No. 1 being the thickest and heaviest and No. 7 the thinnest and lightest, and each grade has a specified breaking stress. Examples of the purposes for which each grade is used are given below.

- No. 1, for shell bags, canvas baths, and blast bags of guns ;
- No. 2, large awnings ;
- No. 4, small awnings, weather screens, boat and gun covers ;
- No. 6, awning curtains and side screens ;
- No. 7, large boats' sails.

Nos. 3 and 5 grades are not issued nowadays (1949). The sails of small boats are made of " cotton duck ".

Royal Navy canvas has a coloured line in it, called a " seam line ", which runs throughout its length close within the selvedge, $1\frac{1}{2}$ -inches within the selvedge of Nos. 1 and 2 canvases, one inch within that of all the other grades, and three-quarters of an inch within that of cotton duck. The seam line serves as a guide to the breadth of the seam when sewing two pieces of canvas together, and it also indicates the material of which the canvas is made ; canvas with a red seam line has a weft of hemp, and canvas with a blue seam line has a weft of flax. In addition to the seam line, all canvas made for the Royal Navy is marked with a wavy blue line which runs across the breadth and throughout the length of a bolt.

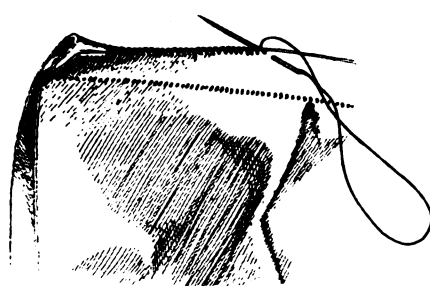
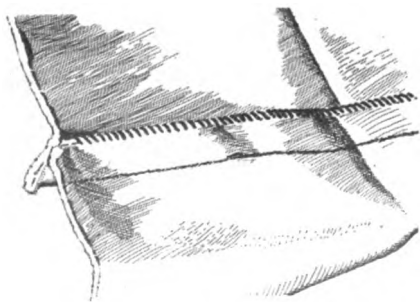
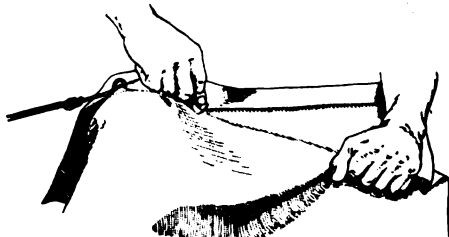
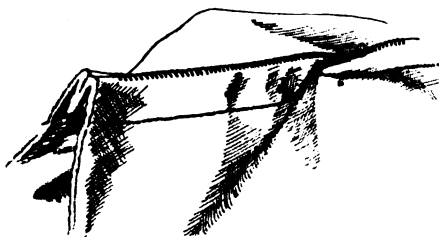
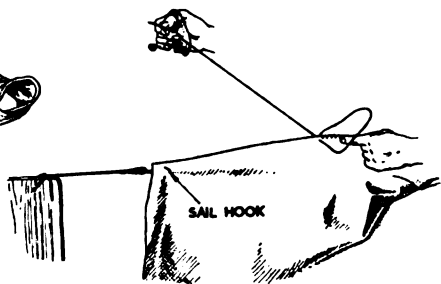
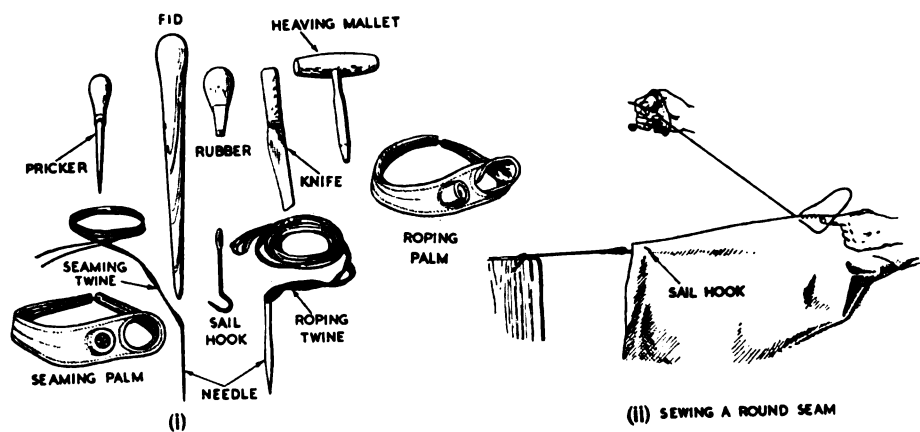


Fig. 139.—Sailmaking, I

Sailmaker's Tools

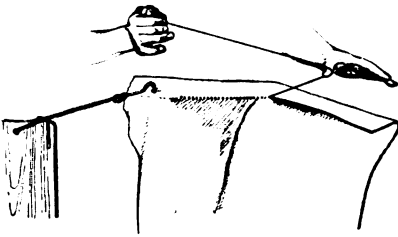
The tools used by the sailmaker are illustrated in Fig. 139(i) and 140(viii), and described below.

- (i) *Needles*.—These are of various sizes, No. 8 being the largest and No. 18 the smallest.
- (ii) *Seaming palms* and *Roping palms*.—These are made of leather and hide. They fit on the right hand to protect it from the needle, and are provided with a small metal cup which is used to push the needle through the canvas or rope. The roping palm has a rather larger cup than the seaming palm and differs also in being fitted with a thumb guard.
- (iii) *Rubber*.—This small tool is used for rubbing down the stitching of a seam to make it lie flat.
- (iv) *Sail hook*.—This is used to hold the canvas when sewing and serves as a third hand for the sailmaker.
- (v) *Knife*.
- (vi) *Heaving mallet*.
- (vii) *Beeswax*.—Used for coating the sewing twine.
- (viii) *Pricker*.—This steel pointed spike with a wooden handle is used for making small holes in canvas, for splicing small wire, and for similar jobs.
- (ix) *Piercing tool* (Fig. 140(viii)).—This has a fluted steel blade and a wooden handle, and is used for making holes in canvas to take brass eyelets.
- (x) *Fids*.—These are tapered pieces of hard wood, of various sizes, used when stitching cringles and eyelets; they can also be used for opening the strands when splicing.
- (xi) *Punches and Dies* (Fig. 140(viii)).—These are for inserting brass eyelets.

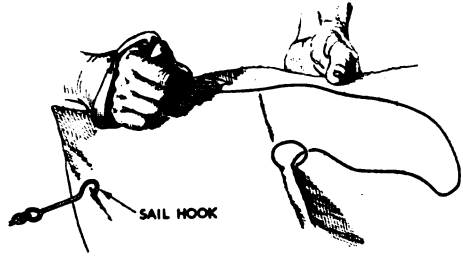
Sewing and Repairing Canvas

Seaming twine is used for sewing canvas, and roping twine for sewing rope to canvas. Twine is always pulled through a lump of beeswax before use as this stiffens and preserves it and also prevents it from kinking; an overhand knot is then made in one end to prevent it from pulling right through the canvas, and the other end is passed through the needle. A beginner will find it difficult to handle lengths of more than three or four feet, and should cut them accordingly; the method of joining on a new length of twine is described below.

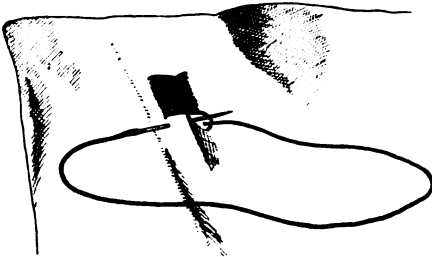
The three chief methods of sewing are known as the "round seam", the "flat seam", and the "sailmaker's darn". The round seam and the flat seam are used for joining two pieces of canvas together, the former being the stronger of the two, and the sailmaker's darn is used for mending a small tear. For the average seaming or darning job on board a No. 13 or No. 14 needle is suitable, and for a roping job a No. 10 or No. 11.



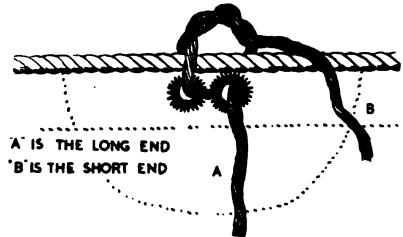
(i) SEWING A FLAT SEAM



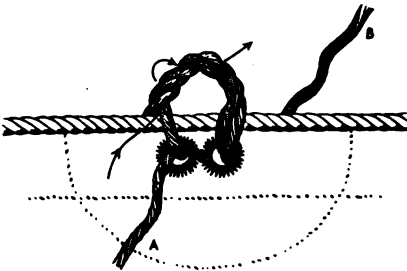
(ii) SAILMAKERS DARN, FIRST STITCH



(iii) SAILMAKERS DARN

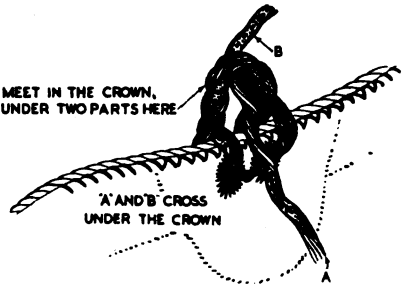


(iv) MAKING AN 8 PARTED CROWN CRINGLE



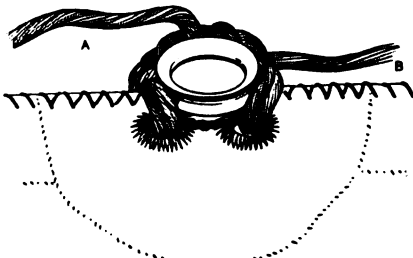
(v) ARROWS SHOW HOW 'A' CAN BE TUCKED INTO THE CROWN

'A' AND 'B' MEET IN THE CROWN,
PASSING UNDER TWO PARTS HERE

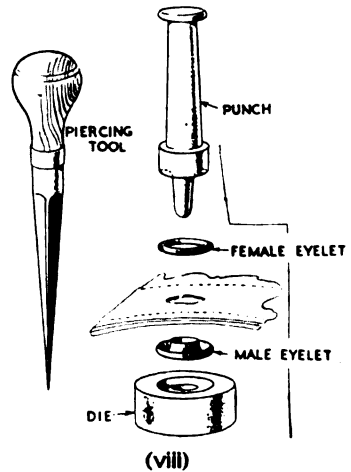


'A' AND 'B' CROSS
UNDER THE CROWN

(vi)



(vii) THIMBLE READY FOR FINAL
TAP WITH MALLET



(viii)

Fig. 140.—Sailmaking. II

Round Seam (Fig. 139(ii), (iii), (iv) and (v)).—One of the strips of canvas to be joined is folded along the seam line and laid with its fold along the top of the selvage of the second piece. The sailmaker then sits facing the sail hook, attaches the work to the hook, and holds it close to his left side with the selvage nearest him and the fold on the far side. Then he makes his stitches by pushing the needle from right to left through the selvage and fold, working towards the hook; not less than three stitches to the inch should be made and good work will have 120 stitches to the yard. When completed the seam is held between the knees and rubbed down flat (Fig. 139(iv) and (v)).

To make a double round seam the second piece of canvas is folded at its seam line and sewn to the selvage of the first, in exactly the same manner (Fig. 139(vi)).

Flat Seam (Fig. 140(i)).—This seam is made by laying the strips of canvas flat and overlapping each other so that the selvage of each lies along the seam line of the other. The sailmaker sits facing away from the hook and sews one selvage to the other seam line by passing the needle down through the lower piece of canvas and up through both, working away from the sail hook. A double flat seam is made by sewing the other selvage to the other seam line in the same manner.

Sailmaker's Darn (Fig. 140(ii) and (iii)).—The canvas is held so that the tear points directly at the sailmaker. The first stitch is then made by bringing the needle up through the canvas just to the left of the end of the tear, then down through the canvas on the right side and up through the tear, and then through the bight of twine so formed (Fig. 140(ii)). Subsequent stitches are made by passing the needle down through the tear, up through the canvas on the left side, down through the canvas on the right side, leaving a small bight in the twine, and then up through the tear and the bight (Fig. 140(iii)). Each stitch is drawn taut as it is finished and the darn actually consists of a series of locked stitches sewn closely together. A cornered rent is darned in exactly the same manner.

To Join on a New Length of Twine.—One length of twine is joined to another by threading the needle with the new length and passing it through the hole made by the last stitch, and then laying the short end of the old length of twine along the seam between the two pieces of canvas and making the next few stitches over the top of it. With a flat seam the old end must first be withdrawn through one piece of canvas before sewing it down as described.

All sewing is finished off by a back-stitch, which is formed by passing the needle a second time, and in the reverse order, through the holes made by the previous stitch.

To Patch a Hole in Canvas.—A square patch more than large enough to cover the hole is cut from a spare piece of canvas. Half an inch of each edge of this patch is then turned down to make a false selvage, and the patch is then sewn on with a flat seam so as to cover the hole on one side. The piece of canvas being repaired is then turned over and the hole in it is trimmed with a knife into a rectangular shape so as to leave a strip one and a half inches broad (or two inches broad if of No. 2 R.N. canvas) all round inside the seam of the patch. Half an inch of this strip is then turned down to form a false selvage, which is sewn to the patch with a flat seam.

Roping

The edges of sails and awnings are roped for :—

- (i) strengthening them where there is a heavy pull along the edge itself, as in the luff of a sail ;
- (ii) binding the edge and so preventing it from being torn by the pull of the cringles.

A larger rope is used for (i) than for (ii).

In some parts of a sail the roping stretches more than the canvas, and this is allowed for by leaving sufficient slack in the canvas, where required, when sewing the rope to it. When sewing rope to canvas the needle is first passed between the strands of the rope and then through the canvas. If in making the stitch the needle is passed through squarely to both rope and sail there will be no slack in the canvas, but, if the needle is inclined to the right, slack canvas will be drawn into the lay of the rope between the strands.

Certain parts of a sail where there is little strain at the edge set better if sewn with some slack in the rope, and this is effected when sewing on the roping by making the stitches with the needle inclined to the left. It may also be noted that the luff of a whaler's mainsail and the upper few feet of its head are sewn with slack canvas, while the lower few feet of the head are sewn with slack rope. All these are finer points of sewing which the seaman is not expected to practise, but he should understand them.

Splices

The sailmaker's splices require above all to be compact, and some strength has to be sacrificed accordingly. Most sailmaker's splices are started in the ordinary way, but all tucks after the first are made with the lay, *i.e.* each strand is taken over the one on its left and then tucked back under the same strand from left to right, and all strands are carefully tapered after each tuck. The most common splices made in this way are the sailmaker's eye splice and the tapered splice, the latter being a short splice joining two ropes of unequal size, such as the luff and head ropes of a whaler's mainsail. In addition, certain special splicing is used in the roping of sails and awnings and is described below.

- (i) The luff of a whaler's mainsail ends at the tack in a sailmaker's eyesplice, and is joined by the foot-rope as follows : one strand of the foot-rope is tucked through the crown and brought back ; then it is married up with one of its fellows, the two are unlaied and laid up after the fashion of a long splice, and the remaining strand is then tucked through the crown and expended by being tucked into the after side of the eye.
- (ii) The wire bolt-rope at the outer edge of a large awning is fitted at each end with an ordinary eye-splice, and into the crown of the eye is tucked a fibre bolt-rope which runs athwartships along the other edge of the awning. A good way of tucking this fibre rope is to lift two strands of the wire, then tuck one strand of the rope from right to left, tuck the second through the same place from left to right, and the third in the same place from right to left. Having been tapered down, all strands of the rope are then taken over the next strand of wire and tucked in a similar manner under the following two strands, but this time in opposite directions. All strands are then again tapered and a

third tuck is made, after which the ends are wormed round the wire rope up to the neck of the eye. The eye is served throughout and the thimble inserted neck first, as for a hawser eye.

- (iii) A rat's tail is used where the roping ends along the edge of a sail. It is made by tapering down the strands and teasing each of them out into three parts. The three parts of each strand are then well waxed and laid up together, left-handed as for a fox. Then the relaid strands are themselves laid up right-handed.

Grommets, Cringles and Eyelets

Grommets.—The holes pierced in a sail to take the cringles are fitted with small grommets, and these are sewn to the canvas on the same side as the roping and close to it, so that when a pull is exerted on the cringle the grommet bears against the rope. Each grommet should be slightly larger than its hole, and it is sewn on by passing the needle down outside and up inside until the whole grommet is covered and secured with round stitches.

To Make a Cringle (Fig. 140(iv), (v), (vi) and (vii)).—Much the most common type of cringle is the eight-parted crown cringle, which is made as described below.

The canvas is held with the roping towards the sailmaker, and a strand of the required size is passed through the left hand grommet so that the nearer part of the strand is from eight to ten inches longer than the farther part; these will be called respectively the long and short ends. The two parts are laid up together with four half-turns and the long end is brought up through the right-hand grommet (towards the sailmaker), thus forming the cringle (Fig. 140(iv)). The same long end is now laid up into the spaces in the bight of the cringle, and on reaching the left side it is passed up through the left-hand grommet; the short end is then passed down through the right-hand grommet (Fig. 140(v)). Both ends are then tucked into the cringle towards the crown, passing under two parts, over one, and under two, and in thus tucking them the ends are crossed in the crown as they are tucked for the last time (Fig. 140(vi)).

Counting round the crown the finished cringle will be found to have eight parts, from which it takes its name. An eight-parted cringle will usually take a thimble of the same size as the component strand, but a more exact guide is given below; a round welded thimble is always used.

<i>Size of strand</i>	<i>Pattern No. of thimble</i>
1½ inches	650
1¾ inches	651
2 inches	652
2½ inches	653

To Insert a Thimble.—The cringle is placed over a fid, with the roping uppermost, and is then stretched by being beaten down firmly with a mallet; the fid is then turned over, point down, and the cringle knocked off. The score of the thimble is then immediately inserted into the crown of the cringle (Fig. 140(vii)), and the thimble itself forced into place by a sharp tap with a mallet, before the cringle has time to recover from its stretching on the fid.

To Insert a Brass Eyelet (Fig. 140(viii)).—Eyelets are made in different sizes and a special punch and die are provided for each size; the pattern numbers for each size of eyelet are given in the following table.

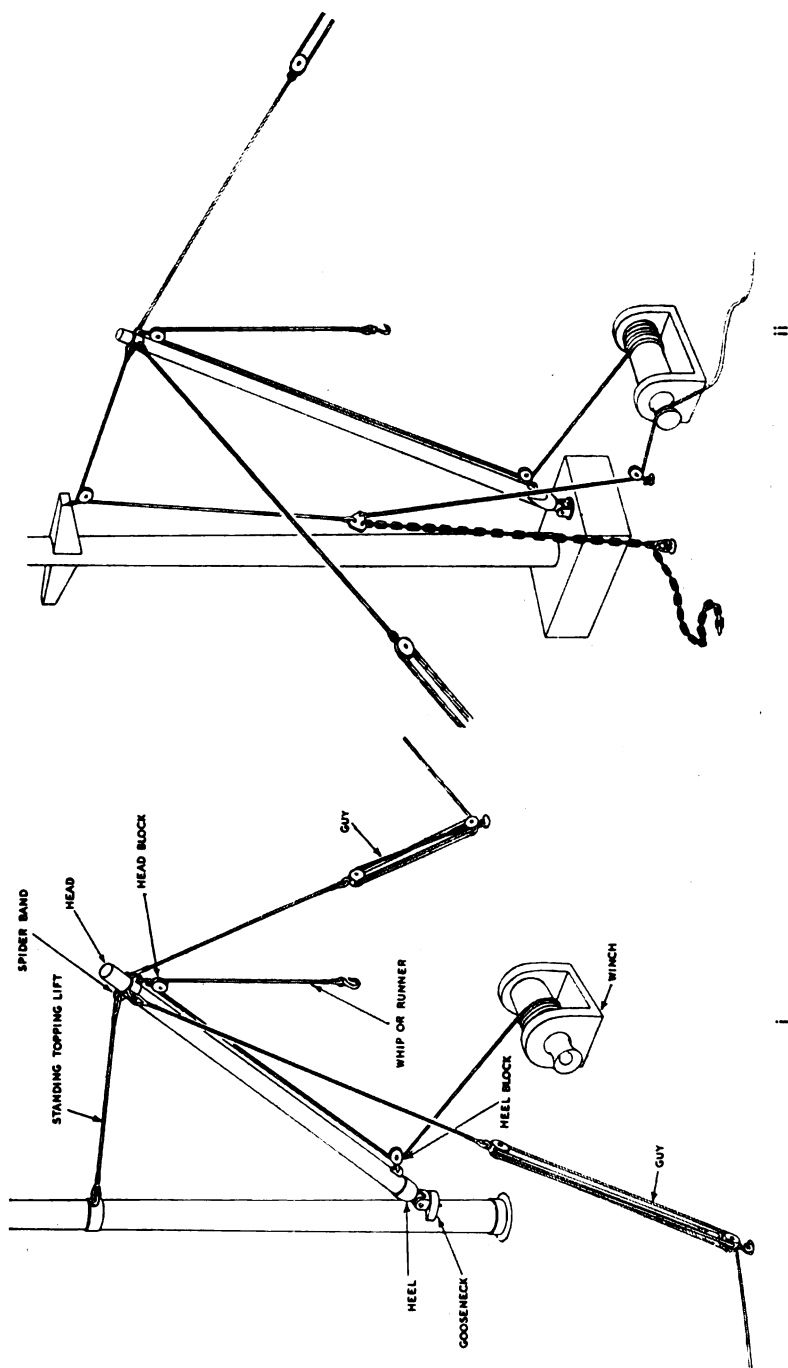


Fig. 141.—Rigs of mast derricks

<i>Diameter of Eyelet in inches</i>	<i>Patt. No. of Eyelet</i>	<i>Patt. No. of Punch</i>	<i>Patt. No. of Die</i>
$\frac{1}{8}$	179	156	156A
$\frac{1}{4}$	180	157	157A
$\frac{5}{16}$	181	158	158A
$\frac{3}{8}$	182	159	159A
$\frac{7}{16}$	183	160	160A
$\frac{1}{2}$	184	161	161A
$\frac{9}{16}$	185	162	162A
$\frac{11}{16}$	186	163	163A
$\frac{7}{8}$	187	164	164A
$1\frac{1}{16}$	188	165	165A

The hole in the canvas should be made with the piercing tool supplied, not cut roughly with a knife, and it should be fidded out lightly but must not be made too large or the finished job will be weak. The male part of the eyelet is put over the die, and then the canvas, which is guided on over a small fid; finally the female part is placed on the top of the male part and tapped down sharply with a hammer and the punch to secure it in place.

DERRICKS, WINCHES AND CRANES

Derricks

Derricks vary considerably in their type, rig, and the manner in which they are worked. In this section some typical Merchant Navy derricks are described, together with some of the ways in which they are worked.

RIGS OF DERRICKS

Some typical rigs are illustrated in Fig. 141. It is customary to provide one winch for each derrick, the whip or "runner" as it is often called being led to the winch drum, and the guys and working topping lift (if fitted) taken as required to the warping drums. The topping lift is usually adjusted to the angle at which the derrick is required to work and is then stoppered by a "snotter". The snotter is usually a length of long-linked chain, shackled to a union plate fitted in the topping lift fall with the appropriate link in the other end shackled to an eye-bolt in the deck (see Fig. 141(ii)).

The positions of the topping lift and whip leading blocks are important. The topping lift upper leading block must be directly above the heel of the derrick, as shown in Fig. 142(a), otherwise the derrick will either cock up or

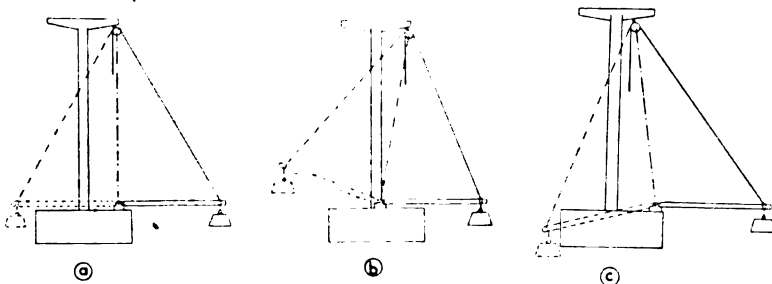


Fig. 142.—Correct and incorrect leads of a topping lift

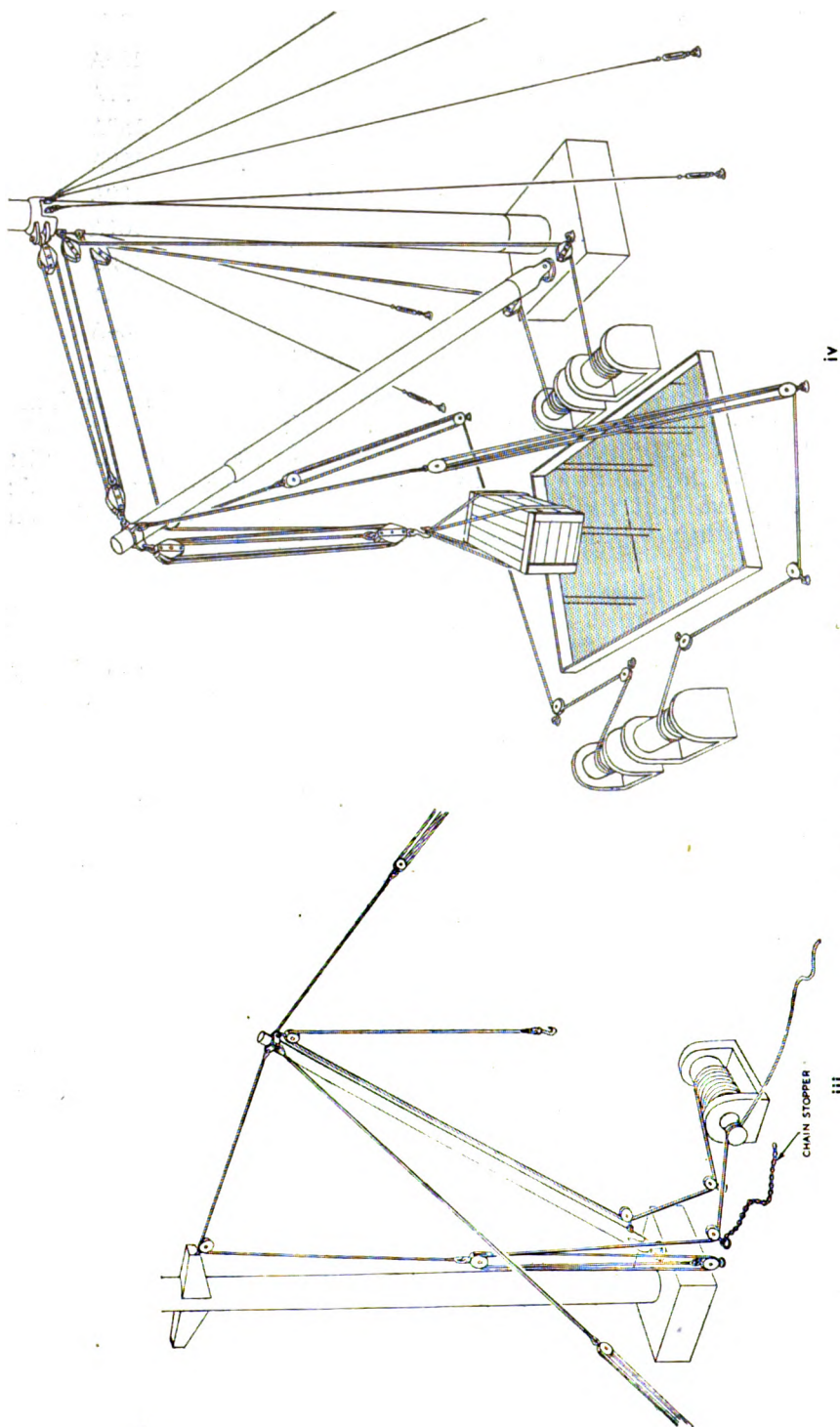


Fig. 141 (contd.)—Rig of mast derricks

droop when it is guyed off the centre-line (see Fig. 142(b) and (c)) ; in heavy derricks, this block may be a trunnion block, hinged vertically to the mast so that it pivots in line with the derrick. The lower leading blocks should be close under the heel of the derrick and should also give a straight lead for the falls to the winch drum and warping drum ; the whip lower leading block is usually triced up to keep it in position when the whip is slacked.

The derricks normally used for working cargo have a safe working load of from 5 to 7 tons. A 5-ton derrick rigged with a single whip is usually limited to a hoist of about 3 tons, this usually depending upon the strength of the derrick ; for a greater load the whip must be rove double as shown in Fig. 143. Heavy derricks with safe working loads of 10 tons or more are

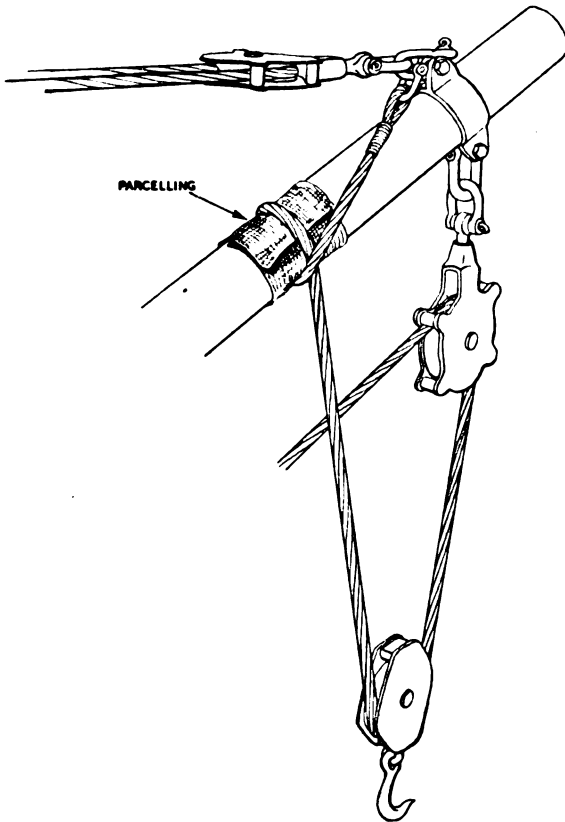


Fig. 143.—Reeving a single-whip as a double-whip

rigged as illustrated in Fig. 141(iv) ; the whip is replaced by a "purchase" with its fall led through an upper leading block on the mast so that it assists the topping lift, and the guys are brought to winches or warping drums.

A large freighter usually carries two extra-heavy derricks, called "Jumbo derricks", one of 50 tons S.W.L. and the other of 30 tons ; they are stowed vertically and clamped to the foremast and mainmast. One ship is now (1949) fitted with a Jumbo derrick to lift 135 tons, but this is unusual.

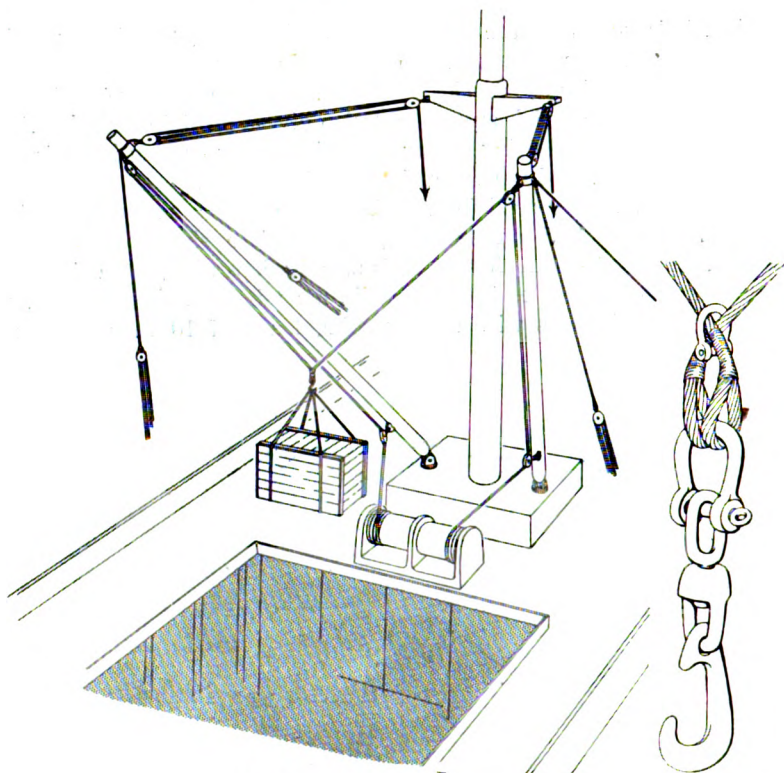


Fig. 144.—Union-purchase method

WORKING OF DERRICKS

(i) *Union Purchase Method*.—A common method of working cargo with hoists of up to $1\frac{1}{2}$ tons is the union purchase, or yard and stay method, in which two derricks are rigged so that one will plumb the hold while the other is turned out over the ship's side to plumb a lighter or the loading wharf. Their whips are joined together by a union hook, or by the method shown in the inset of Fig. 144, either of which prevents the joining shackle being unduly stressed when the whips pull in opposite directions. The load is first hoisted by one derrick while the slack in the whip of the other is taken down; when the load is clear of the hatchway or bulwarks it is then transferred to the other derrick and lowered into the lighter or on to the wharf, as the case may be. To avoid undue stress the angle between the two whips must be kept as acute as possible, and the longer are the derricks the more acute will it be possible to make this angle. Auxiliary guys should always be rigged if there will be any heavy sideways pull on the derricks.

(ii) *Deadman or Backweight* (Fig. 145).—Another quick method of working light cargo is to use a swinging derrick, the inboard guy of which is led through a block at the head of a stationary derrick at the opposite side of the hatch. To this guy, at a suitable height, is hung a weight known as a "deadman", or "backweight", and the outboard guy is rove as a runner, the hauling part of which is brought to a winch and hauls the derrick against the weight of the deadman. When the winch is reversed the weight of the deadman hauls the derrick back into position.

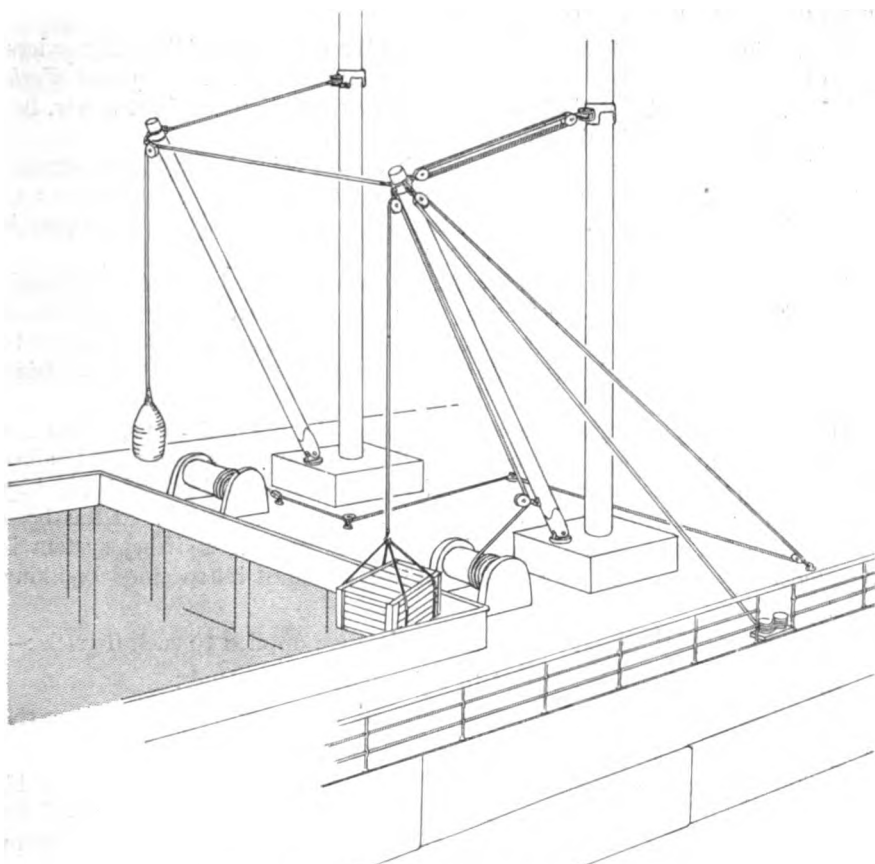


Fig. 145.—“ Deadman ” or “ backweight ” method

(iii) *Heavy Lifts.* For loads of above $1\frac{1}{2}$ tons a swinging derrick and greater care in working are necessary. For hoists of above 3 tons the whip must be doubled (as shown in Fig. 143) and it must be of considerable length ; if the whip is not fitted with a soft eye the sheaves of the blocks must be removed in order to reeve it ; alternatively a snatch block can be used, but this is neither as satisfactory nor as safe. Before hoisting a heavy load all blocks should be carefully overhauled, greased and oiled to avoid increasing the load on the tackle falls through undue friction, and shackles should invariably be well moused before starting operations.

When working a heavy derrick it must be carefully and adequately guyed so that it will be under complete control at all stages of hoisting and lowering ; to be effective the guys must be led at a broad angle with the derrick and as nearly horizontally as practicable. If the load is particularly heavy additional auxiliary stays must be fitted to the mast to enable it to withstand the heavy stresses involved. If the load is heavy enough to list the ship when the derrick is swung outboard it may be necessary to keep her upright by ballasting, not only to preserve the ship's stability but also to prevent any tendency for the derrick to take charge through the upper leading block of the topping lift no longer plumb the heel of the derrick. (For precautions when working derricks see page 240).

TESTING DERRICKS AND HOISTING GEAR

The testing of derricks in the Royal Navy is regulated by Admiralty orders, and in the Merchant Navy by the *Docks Regulations* or the *Factory and Workshops Act*. A general description of Admiralty regulations is given below, but the orders themselves should always be consulted.

All hoisting systems are tested as a unit before being brought into service, and subsequently at regular intervals of one year if used for torpedoes or ammunition, and of two years if for other purposes. Associated spare gear is tested separately at the same time as the main system.

All shackles, hooks, chains, and similar fittings are tested to their proof loads before being taken into service, but are only retested when included as parts of a hoisting system. No orders are issued regarding annealing, this being left to the discretion of dockyard officers during the periodic survey and test of lifting gear.

The tests during manufacture of wire rope made to Admiralty specification are sufficient to guarantee its strength, and further samples are not tested before bringing a rope used for hoisting into service. The safe working load is fixed by the Admiralty at $\frac{1}{8}$ th of the specified breaking stress. Rope that has been used for hoisting and is not otherwise tested as part of a lifting system is subjected every two years to a proof load of $\frac{2}{5}$ ths of its specified breaking stress.

Procedure for Testing. Three separate tests are applied to each derrick :—

- (i) the system is loaded at rest to twice the working load ;
- (ii) the working load is then raised, lowered, topped and traversed over the complete range of travel so as to test every part of the gear ;
- (iii) the system is then tested as in (ii) but with a "running load" of $1\frac{1}{2}$ times the working load ; but should the winch or motor bollard be unable to lift this running load it is similarly tested with the maximum load which the winch or motor bollard will lift.

On completion of these tests all parts of the system are carefully examined.

Markings on Derricks and Hoisting Gear. In the Royal Navy a tally plate is affixed on or near each hoisting system and marked with the following information :—

- a statement that the system was tested with the approved rig ;
- the place and date of test ;
- the static test load ;
- the running test load ;
- the safe working load ;
- the initials of the person responsible for the test.

The safe working load is that load approved for the system as a whole ; individual items of equipment should not be marked with their working loads as this might be misleading.

Winches

A steam or electrically driven winch is usually provided for working the whip of each derrick with which a ship is equipped. Cargo winches for working the running rigging of the derrick may be provided with warping drums on each end of the main shaft ; such winches may be fitted with a clutch so that the warping drums can be worked independently of the main drum.

All steam winches are usually controlled by a throttle and a reversing lever, but otherwise they differ widely from each other, particularly in the method by which their loads are lowered, and care is therefore necessary when first driving a winch with which you are unfamiliar. One type of steam winch designed for quick lowering has a friction clutch between the engine and the drum ; when lowering, this clutch is disengaged and the load is allowed to descend by its own weight, its speed being controlled by the brake.

An electric winch is operated by means of a controlling switch and a foot-operated mechanical brake. The brake is used to slow down the winch, but not to stop it as this would damage the electrical mechanism. A powerful automatic brake is also fitted for preventing any movement of the winch when no current is flowing through the motor, which may occur if the controlling switch is broken or if there is a failure of electric power ; a steam winch has no automatic brake and so will walk back if the steam pressure fails unless the hand brake is applied. For quick lowering, the automatic brake of some electric winches can be held off mechanically when the controlling switch is broken ; the load then lowers itself by its own weight, the speed of lowering being controlled, and the winch stopped when required, by the foot brake. Some steam and electric winches are fitted with two gears, the double (or lower) gear being used for heavy loads.

Cranes

Cranes are quicker and more convenient in operation than derricks, but, weight for weight they are not nearly so strong. Their characteristic feature is a jib, or projecting hinged arm, the head of which can be raised or lowered by a topping lift rove as a tackle.

The lifting rope, also of wire, is rigged as a single whip ; it leads over a sheave at the head of the jib and is called the "purchase". Between the purchase wire and the hook is a weight called the "ponders ball" (contracted from ponderous ball), the function of which is to help the purchase to overhaul when there is no load on the hook ; in some cranes designed for recovering seaplanes the ponders ball may be made in two halves and incorporate a shock absorbing device. Besides hoisting and topping, a crane can be slewed or trained to plumb a hoist, and some dockside cranes can also move bodily, usually along rails.

The working load and maximum radius permitted are usually engraved on the maker's nameplate, and cranes supplied to H.M. ships are designed to train with their full working load with the ship listing up to, but not more than, five degrees ; these limits must not be exceeded in practice. A safe loading indicator and an electrically operated bell are fitted to give warning should the specified safe working load of the crane be reached or exceeded ; in addition, overload trips are fitted in the electrical system, but these do not operate until the overload is considerable. The structure of a crane is designed to be stronger than its lifting ropes, except, of course, when subjected to any undue sideways pull ; when a crane has been overloaded any signs of resultant damage should therefore first be sought in the wire lifting ropes. (For precautions when working cranes see page 240).

PURCHASE AND TOPPING LIFT

The upkeep of a crane is chiefly the responsibility of the ship's electrical department, but the seaman is responsible for the care and maintenance of the topping lift and purchase ropes. These two wire ropes are of different length and size and so are not interchangeable, and they differ also in cranes of different type. A spare topping lift and purchase are carried for each crane in the ship

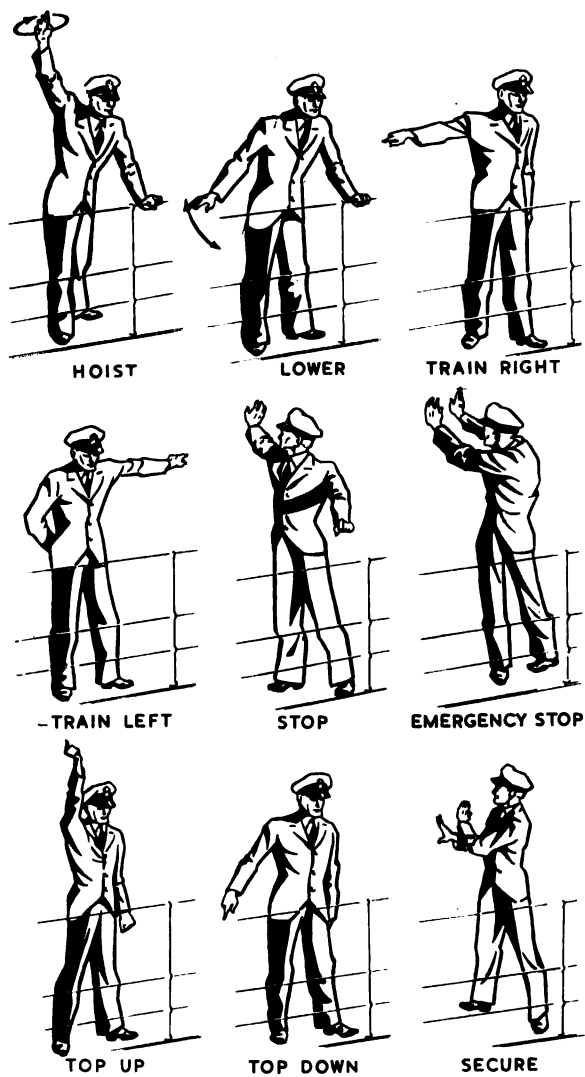


Fig. 146.—Code of hand signals when working cranes or derricks

The purchase rope is specially constructed to prevent it from spinning when hoisting a load, and consists of twelve outer strands of left-handed Lang's lay laid up round three flattened inner strands on a hemp core; the outer strands have six wires each and the inner ones twenty-four. The outer end of a purchase rope is fitted with a socket to take the ponders ball, and the inner end is fitted with a socket or solid thimble to fit the anchorage bolt on the winding drum.

In most cranes the topping lift consists of two twin ropes, each of 6×37 construction Lang's lay; they are usually fitted at both ends with solid thimbles to take the anchorage bolts on the winding drum. Both these ropes should always be renewed at the same time, otherwise they will not share the load fairly because the older rope would be longer, due to stretching, than the new one.

Maintenance consists chiefly in a periodical examination, as laid down for wire ropes, and regular lubrication of the ropes and pulley grooves with a mixture of 95 per cent. grease, Patt. 861, and 5 per cent. graphite. When renewal becomes necessary the jib of the crane is lowered into its stowage, the pulley rope-guards are removed, and the old ropes unrove and replaced by the new ones. The topping lift ropes, being of single Lang's lay, may tend to unlay when being handled; this can be detected by watching the free end as the rope is rove, and should any turns come out of the lay they should be replaced before the second end is anchored.

TESTS

Cranes are tested by dockyard officers as nearly at yearly intervals as is practicable, and an item requesting that the test be undertaken should be inserted in the *Pink Defect List*. Details of these tests are given in Admiralty orders and mainly consist in working the crane through its full authorised limits when loaded with its maximum working load, the ship being upright. Electrical cranes are then tested slowly with a running load 50 per cent. in excess of the full working load, but for hydraulic cranes this overload is only hung on the hook and the gear remains stationary. On completion of these tests the wire ropes are examined in place by dockyard officers, and if the ropes show signs of injury they must be unrove by the ship's staff and taken into dockyard for complete survey; this survey must in any case be carried out at intervals of not less than three years.

SLINGING

The choice of a sling and the manner in which it is used depend upon whether one or a number of objects are to be slung in one hoist, the weight of these objects, and whether they are robust or fragile. If a number of objects are slung in one hoist the load is called a "set".

The general principles of slinging are illustrated in Figs. 146 and 147, the main requirement being that the sling should be sufficiently strong and hold the load securely without crushing it, and the simpler the sling the easier it will be to handle. It is also important that a load should not be allowed to spin, because such spinning may loosen and eventually draw the eye splice of the whip, and that the load should be as steady as possible, and not swinging, at the start of the hoist.

It is the duty of the slinger to prepare a set, to pass the sling or slings and hook it on, and to tend and steady the load until the crane or derrick has taken the full weight. He is also responsible for giving the necessary orders to the

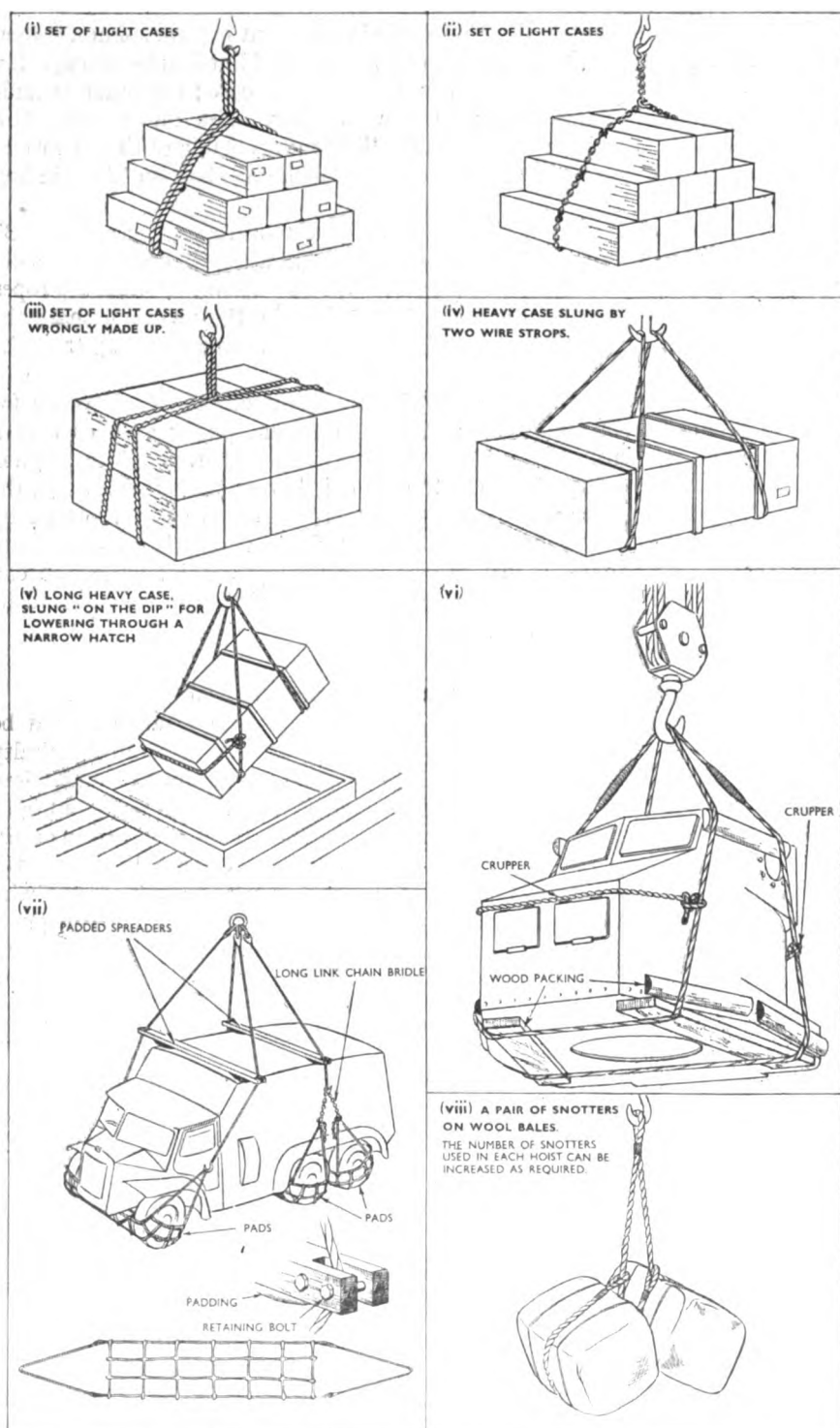


Fig. 147.—Methods of slinging cargo, I

winch or crane driver, who is seldom in a position to see all that is happening ; such orders should never be by word of mouth because orders given in this way are very liable to misinterpretation. The orders should be passed by a code of hand signals, and such a code which is widely used in this country is illustrated in Fig. 146.

NOTES ON SLINGS AND SLINGING

In Fig. 147 (i) and 147 (ii) two sets of light but stout cases are shown in a sling which is made to grip them by being passed through, or hooked on to, its own part. If this method be used for a heavy load, however, not only will the cases be subjected to a severe crushing effect, but the bight or the hook may slip as the hoisting gear takes the weight, which would cause the load to tilt, perhaps dangerously. It should also be noted that when a strop is passed through its own part it cannot support as heavy a load as when each of its parts is placed over the hoisting hook.

Heavy or fragile gear is therefore slung by the more positive method illustrated in Fig. 147 (iv), in which a single heavy case is prevented from slipping by virtue of its weight. Should there be any likelihood of it slipping, however, one or more "cruppers" must be used ; these are illustrated in Fig. 147 (v), which shows a case slung "on the dip" for passing through a small hatch.

Loads should be arranged so that their centre of gravity is as low as possible, and so that the angle between the parts of the sling is kept small. Figs. 147 (i) and 147 (ii), show the right methods, and Fig. 147 (iii) shows the wrong method of assembling a set of small cases. When preparing to hoist heavy gear of some hard material, wooden packing pieces should be placed to protect the slings from sharp nips, as shown in Fig. 147 (vi). *With any kind of load the splice must be clear of both the hook and the load.*

A single sling fitted with an eye at each end is called by stevedores a "snotter" and it must not be confused with the snotter used for stoppering a derrick topping lift. Snotters, which are normally made up in pairs, give a good grip, are simple and quick to attach, and convenient when dealing with large bales, of wool for example ; instead of piling the bales into sets for hoisting, one snotter is passed round each bale and then placed direct on the hook (Fig. 147 (viii)), the hoist thus consisting of a convenient number of snotters and bales. Carcases of meat can be similarly dealt with.

Though used extensively in commercial practice, the Royal Navy is not allowed to use can hooks for hoisting casks or barrels ; bale sling strops or butt slings must be used instead, and can hooks may be employed only for breaking bulk.

Except for cargo nets, slings can be made of chain, cordage, or wire rope ; nets are of cordage or wire rope only. Chain gives the best grip, but it has the disadvantage of being too rough for fragile gear, and should there be a weak link it cannot always be detected ; chain is also more susceptible to damage from a bad nip than cordage or wire rope. Cordage is easy to work, and being soft does less damage to paint and to packages, but it requires careful watching for chafe and rot. Wire rope slings are reliable and defects in them should be easily detected.

Certain heavy units such as locomotives should have special slings made and provided for them, and boats supplied to the Royal Navy have their own slings made for them which are tested annually to twice their working loads.

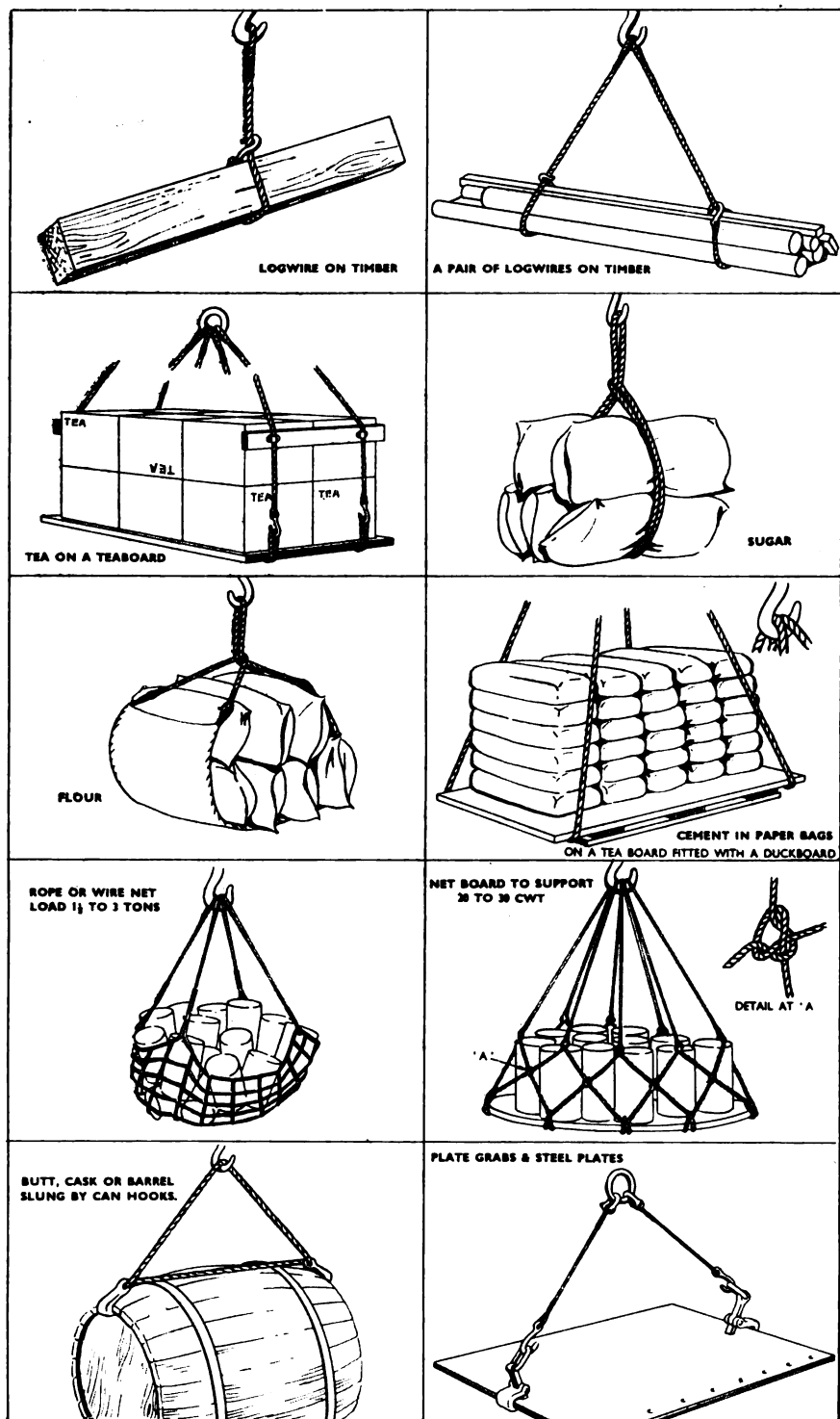


Fig. 148.—Methods of slinging cargo, II

WORKING LOADS

In British commercial practice the working loads of slings must either be marked on the slings themselves or on a board in the vicinity of their stowage. It is equally important that the weight of every hoist should be known accurately, and packages are therefore marked accordingly before shipment.

The working load of a sling can be calculated approximately if the combined strengths of the parts supporting the load and the angle formed between them are known ; the wider the angle the less will be the working load, and an allowance must also be made for loss of strength due to sharp bends in the parts of the sling.

The calculation is simple. An allowance for the angle between the parts, which can be calculated from the following table, must be subtracted from their total strength ; if there are more than two parts on the hook the angle taken should be the greatest one between diagonally opposite parts.

<i>Proportion</i>	
<i>Angle</i>	<i>to be subtracted</i>
0°	0
50°	0.1
75°	0.2
90°	0.3
105°	0.4
120°	0.5

If the sling is of wire rope, 25 per cent. of the remainder is then subtracted to allow for bends or nips in the sling, but if of chain this allowance should be 50 per cent. ; chain is very much weakened if sharply bent, and great care must therefore be taken in passing such slings. If there are no appreciable bends, or if they are well protected by thimbles, this correction can be omitted.

Example. A load is slung, as shown in Fig. 147 (iv), by two 2-inch wire strops. The angle between the parts is 60°. What is the working load of the slings ?

Breaking stress of one part	=	$2^2 \times 2 = 8$ tons
Working load of one part	=	$8 \div 8 = 1$ ton
Working load on four parts	=	4 tons
Less 4×0.2	=	0.8 tons
		3.2 tons
Less 25%		0.8 tons
Working load of slings		2.4 tons

In assessing the strength of a sling in which a number of parts or legs are brought to a ring it must be remembered that the ring may prove to be the limiting factor.

Slings used in the Royal Navy are designed with a factor of safety of 8, but in commercial practice it is usually only 5 or 6. The enormous quantity of cargo loaded and discharged in a commercial port makes the use of lighter gear well worth the extra care and inspection involved.

Cargo nets used in the Royal Navy should lift the amounts shown below if in good condition, evenly loaded, and correctly slung.

Nets made of cordage	1½ tons ;
Nets made of wire rope	3 tons.

Tea boards (*i.e.* wooden platforms on which a set is made up), used in commercial practice usually have a working load of about 1½ tons.

EXTEMPORE DERRICKS, SHEERS, AND GYNS

When no suitable crane or derrick is available for lifting a heavy object, some form of derrick, sheers, or gyn must be specially rigged for the purpose.

A Standing Derrick (Fig. 149) is a single spar stayed by rigging and having a tackle at its head for hoisting a load. Its head is supported by a topping lift, or, if there is no suitable overhead attachment point for a topping lift, it is supported by a "back guy". "Side guys" are fitted to give lateral support, and, if there is a suitable attachment point, a martingale, or "fore guy", may be led downwards from the head to prevent the head from springing upwards or backwards when hoisting or lowering the load.

If it has an efficient topping lift led from a point approximately vertically above the heel the loaded derrick can be slewed to a limited extent as well as being topped and lowered; if the load is heavy, however, or if a back guy is fitted, or if the topping lift attachment point is not vertically above the heel, slewing must not be attempted.

Its heel is stepped on a slab of wood called a "shoe", which is placed on the deck to distribute the weight and thrust of the derrick when under load; these shoes should always be used for extempore derricks, sheers and gynes, except when hoisting light loads, and when used ashore they are usually sunk level with the ground. When derricks, sheers, or gynes are erected on board for hoisting heavy weights the deck on which they stand must be well shored up.

A Swinging Derrick (Fig. 151) is made up of two spars, one of which is upright and well stayed by guys, and the other of which is secured to the first by a strop, called a "snotter", and a topping lift, so that it forms a swinging boom. Working guys are led from the head of the boom as in a permanent derrick, and the boom can be topped with the load slung and also be slewed through an angle of up to 120°.

A derrick of this type is not suitable for heavy loads, however, because of the stress imposed on the snotter. In addition it is often difficult to rig a fore guy for the upright spar, though another spar lashed to it so as to form a strut, and called a "pry pole", affords an effective alternative.

Sheers (Fig. 152) consist of a pair of spars, called "legs", which are lashed together and crossed near their heads, the cross thus formed being called the "crutch"; they are supported in a vertical or an inclined position by rigging, and a tackle for hoisting the weight is secured to the crutch.

The overhead rigging consists of either a topping lift and martingale or a back guy and fore guy; as sheers need no lateral support side guys are not fitted. The topping lift, if fitted, should be led to a point aloft so that it makes, as nearly as possible, a right angle with the sheers when they are loaded; if a back guy is fitted it should be led to a point equidistant from the heels of the legs and so as to make as broad an angle as possible with the sheers.

Sheers can be topped up or lowered through a limited angle, the extent depending upon the lead of the topping lift; if a back guy is rigged, however, neither sheers nor derricks may be canted to an angle of more than 20° with the vertical. As sheers are made of two spars they are stronger than derricks of equal size, but they are clumsier and take longer to rig.

A Gyn (Fig. 155) consists of three spars with their heads crossed and lashed together and their heels opened to form a tripod. A gyn is stronger than sheers and standing and swinging derricks, and it requires no rigging to support it, but

it can be used only for a straight lift and cannot normally be traversed with its load slung.

Principles of Rigging Derricks, Sheers and Gyns

Owing to obstructions in the vicinity of the position in which they will be required, lack of a clear lead for purchase, topping lift, or guys, and other special circumstances, it is impossible to give exact detailed instructions for rigging these appliances; their efficiency will largely depend upon the exercise of ingenuity and common sense in applying the principles described below.

The rigging for both sheers and derricks must be led so as to enable it to do its work efficiently. As already stated, the best lead for a topping lift is at right angles to the derrick and towards a point vertically above the heel, but this will often not be possible in practice; an angle of 60° or more between the topping lift or back guy and the derrick will be reasonably effective, and it should never be less than 45°.

Similarly, the angle between the side guys and the derrick should if possible be 60° or more, and these should not be inclined at a greater angle than 30° (*i.e.* at a slope of not more than 1 in 2) with the horizontal.

Care must be taken that any tackles used, in the guys for example, do not develop turns, and "anti-twisters" should be fitted to the blocks where necessary.

Sheers, derricks and shores are subjected to a longitudinal or buckling stress, and in this respect the strength of any particular spar depends upon its thickness, its length, and the type of wood of which it is composed. A useful approximate formula for determining the safe thrust which a good spar will withstand is:—

$$T = \frac{Kr^4}{L^3}$$

where T = safe thrust in tons,

r = mean radius in inches,

L = length in feet,

K = 6 for oak or teak,

3 for Baltic fir, larch, pitch pine, etc.

Example. The only available spars in a ship are three fir spars, each 15 feet long and 6 inches in diameter. What load can be safely lifted by a standing derrick, sheers and a gyn rigged with these spars?

$$T = \frac{3 \times 3^4}{15^3} = 1.08 \text{ tons}$$

The safe loads are, therefore,

standing derrick — 1 ton,

sheers — 2 tons,

gyn — 3 tons.

TO RIG A STANDING DERRICK (Figs. 149 and 150)

Strops for attaching the purchase and topping lift (or back guy) are first placed over the derrick head, and they are prevented from slipping down either by wooden projections called "thumb pieces" (Fig. 150 (ii)) screwed or nailed in place, or by a rope "collar" (Fig. 150 (i)) put on the spar like a whipping. These strops should lie close together so as to avoid a bending stress on the spar.

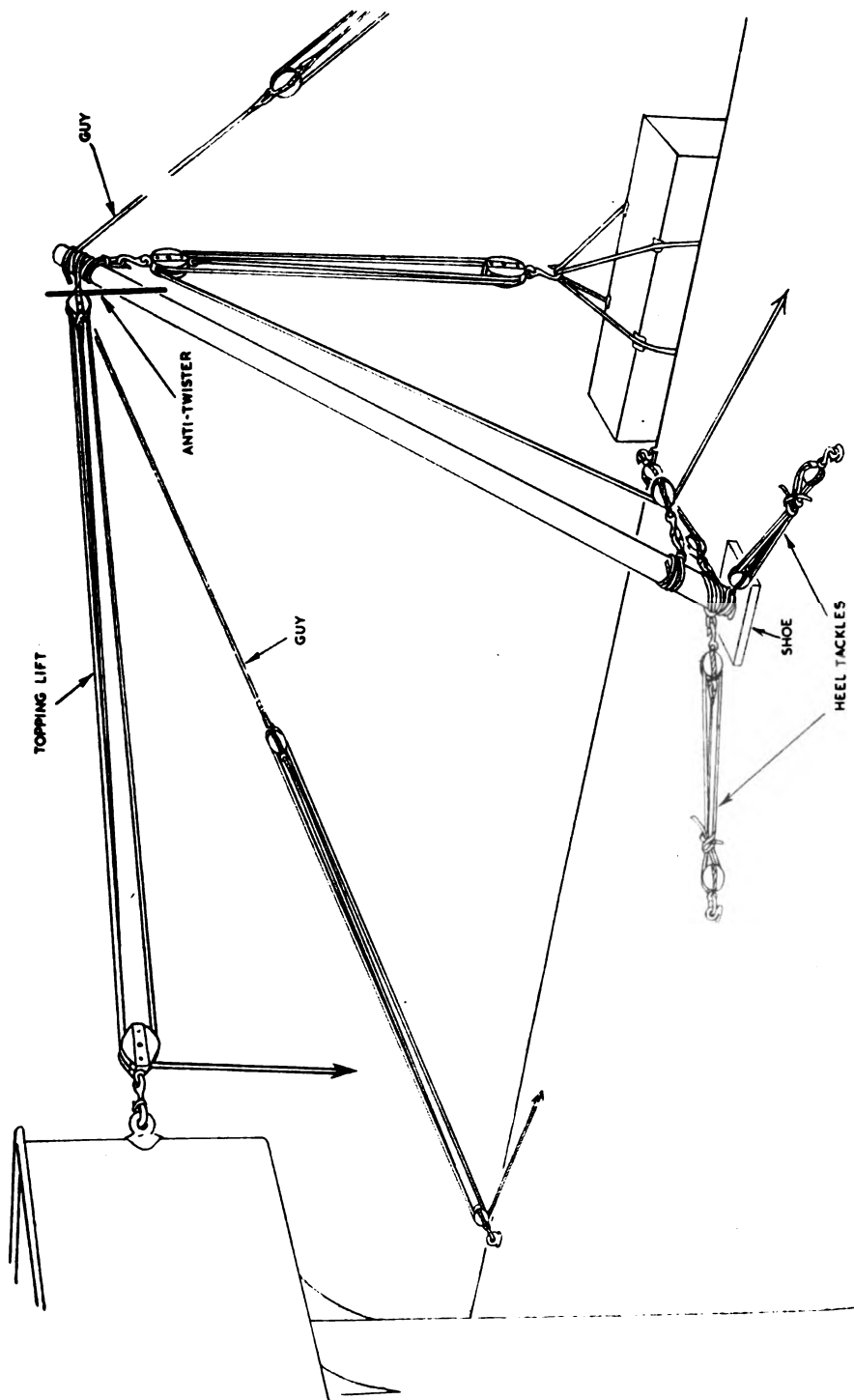


Fig. 149.—A "standing " derrick

The guys, which consist of single parts of cordage or wire rope, are then middled and clove-hitched over the head of the spar, above the strops, tackles being attached if required.

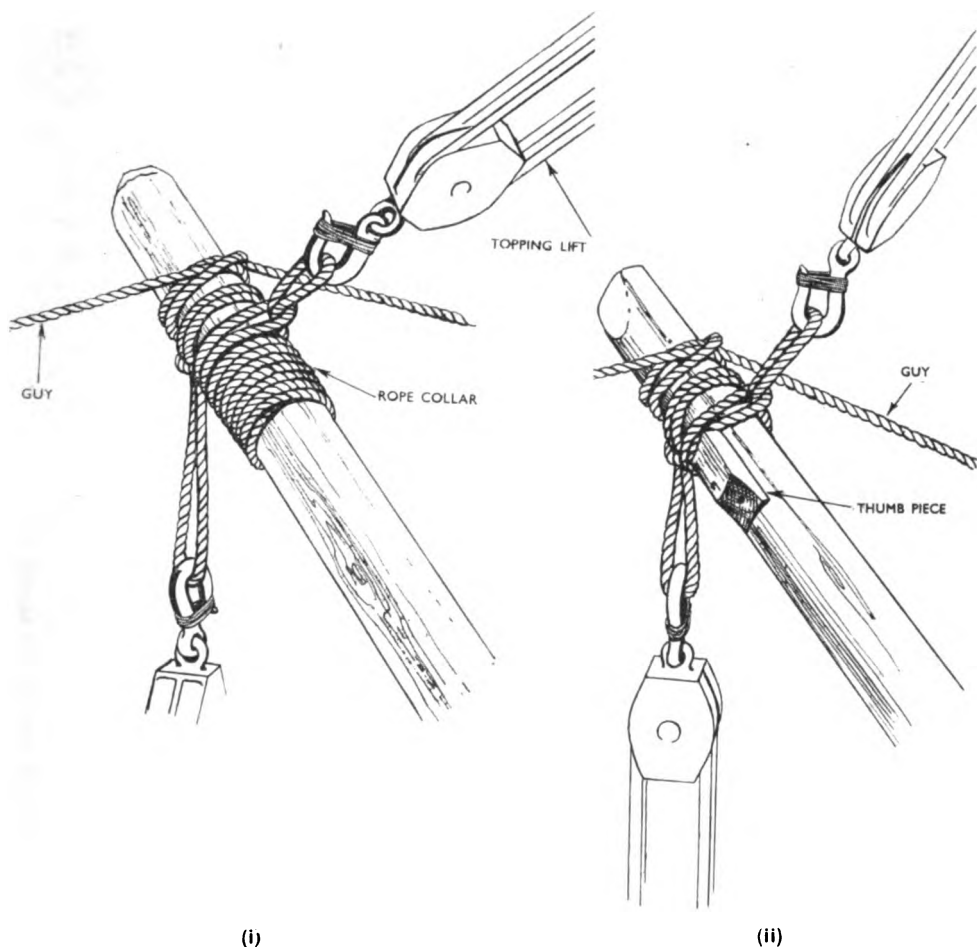


Fig. 150.—Methods of rigging the head of a derrick using rope collars or thumb-pieces

The shoe should be hollowed out to fit the foot of the derrick so as to distribute the thrust fairly, but where this is not possible a useful alternative is to step the foot of the derrick on a sandbag laid on the top of the shoe. The distance from the foot of the derrick to the point of attachment of the purchase and topping lift is known as the "effective length" of the derrick.

The heel of the derrick is kept in place by tackles, which must be led so that they will support it in every direction, and particularly from that in which the derrick will be raised and lowered. The strops for the heel tackles must be kept as low down as possible, otherwise the tackles will be heavily stressed as the derrick is raised.

The fall of the purchase is rove through a leading block secured to a strop round the heel of the derrick, the strop being prevented from slipping up by thumbpieces or a rope collar.

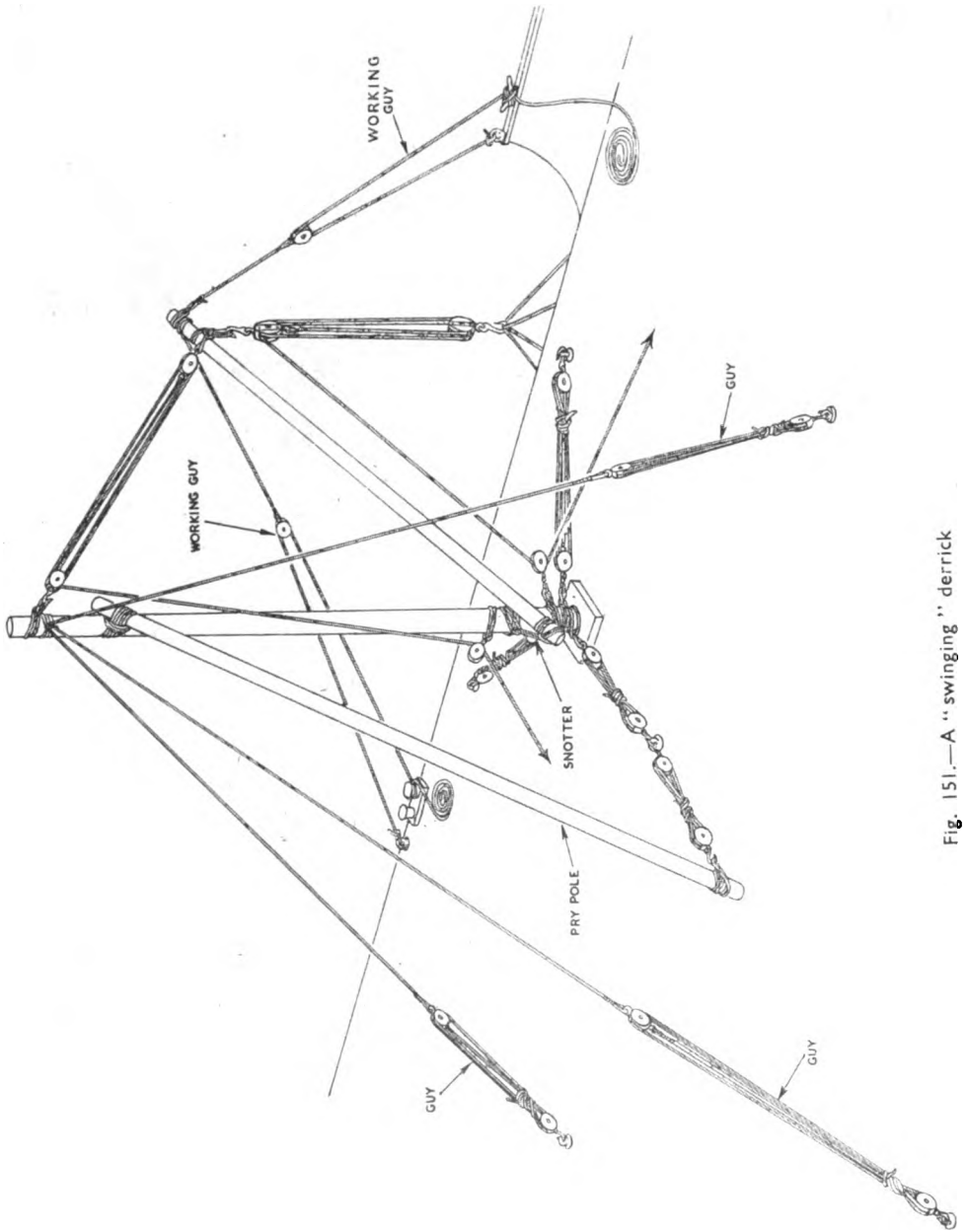


Fig. 151.—A "swing" derrick

TO RIG A SWINGING DERRICK

The upright spar is first erected, and is inclined somewhat away from the load so that it will become vertical as the boom takes the weight. It must be well supported by guys, each strong enough to take the entire pull of the topping lift as the boom swings round. The arc through which the boom is required to swing must, of course, be left clear. A strop to take the upper block of the topping lift is placed over the head of this spar above the guys.

The spar which is to form the boom is now laid midway between the intended limits of its horizontal travel, and with its heel close against the upright spar and projecting on the side away from the load. The head of the boom is rigged as for a standing derrick, but the heel is attached to the upright by means of the snorter, as shown in Fig. 151. If no suitable strop for the snorter is available a bight of rope can be passed round the boom, then through its own bight, and then be half-hitched and dogged round the upright spar in the same way as a tail jigger is put on a wire rope.

The falls of the topping lift and purchase are led through blocks shackled to strops at the foot of the upright spar, the strops being kept in place by thumb pieces or rope collars.

As the leading block for the hauling part of the purchase fall is to one side of the boom the latter is subjected to a sideways pull when the purchase takes the weight, and the boom must therefore be adequately guyed.

In order to keep the stresses on the boom, topping lift and guys to a minimum the boom should cross the upright as low down as possible without fouling the ground or deck, and the effective length of the boom (from where the spars cross to where the topping lift and purchase are attached) should be as short as the reach required for the derrick will allow.

TO RIG SHEERS (Figs. 152, 153 and 154)

The spars for the legs are laid side by side with their heels together and their heads supported conveniently clear of the ground or deck; those parts which will be covered by the lashing are then parcelled to prevent chafe, and the heads are then lashed together as described below and illustrated in Fig. 153.

The legs are first crossed and the lashing made fast to one of them by a timber hitch, either above or below the cross, and then a sufficient number of round turns (usually 14 or more) to cover the cross are taken round both legs. The end is then brought up between the legs, passed down between them on the opposite side of the cross, and brought up again as before, so as to form a frapping turn binding the whole lashing together. Four or five of these frapping turns having been applied the lashing is completed by a clove hitch taken round the opposite leg to the one to which it was originally attached; it is important that the frapping turns are correctly put on, close to each other, and hauled taut.

Choice of the stuff to be used for the head lashing depends on the size of the spars and the weight to be lifted; this is best judged by experience, but the following is given as a general guide:—

<i>Weight to be lifted</i>	<i>Lashing</i>
Up to 2 tons	2½-inch manila
From 2 to 5 tons	2-inch F.S.W.R.
From 5 to 20 tons	2½-inch F.S.W.R.

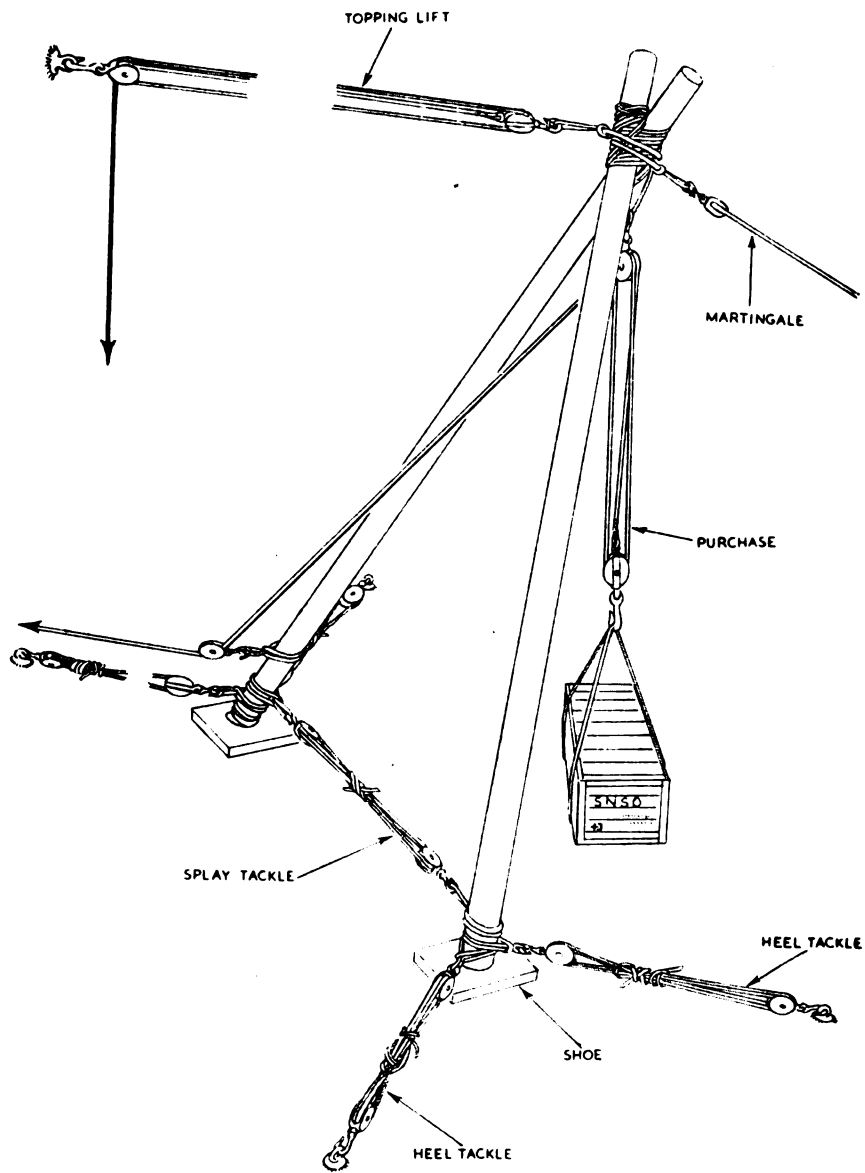


Fig. 152.—Sheers

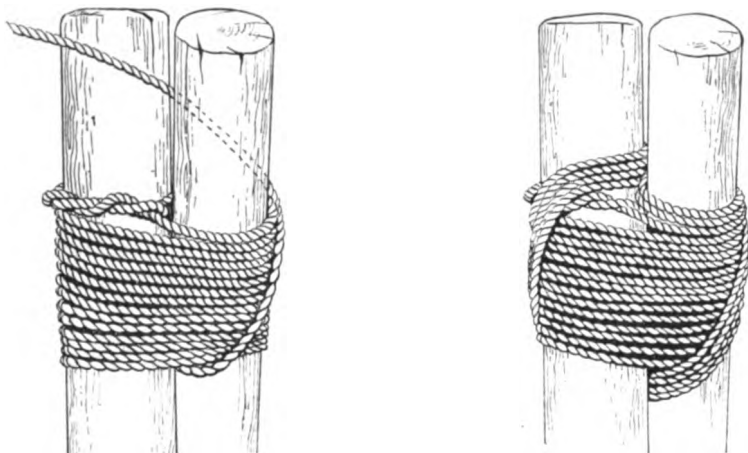


Fig. 153.—Passing the head lashing of sheers

When the head lashing has been completed the heels of the legs are opened out to the required distance, and thus opening them out sets up the head lashing so taut that it binds the legs securely together where they cross. The strop for the purchase is now put on and must be long enough to enable the block to swing clear between the legs; it is put on by slipping it up the top leg and passing it down over the head of the lower leg so that it will bind the two together when under load (Fig. 154). Pads of canvas must be placed under it to prevent it from chafing the lashing.

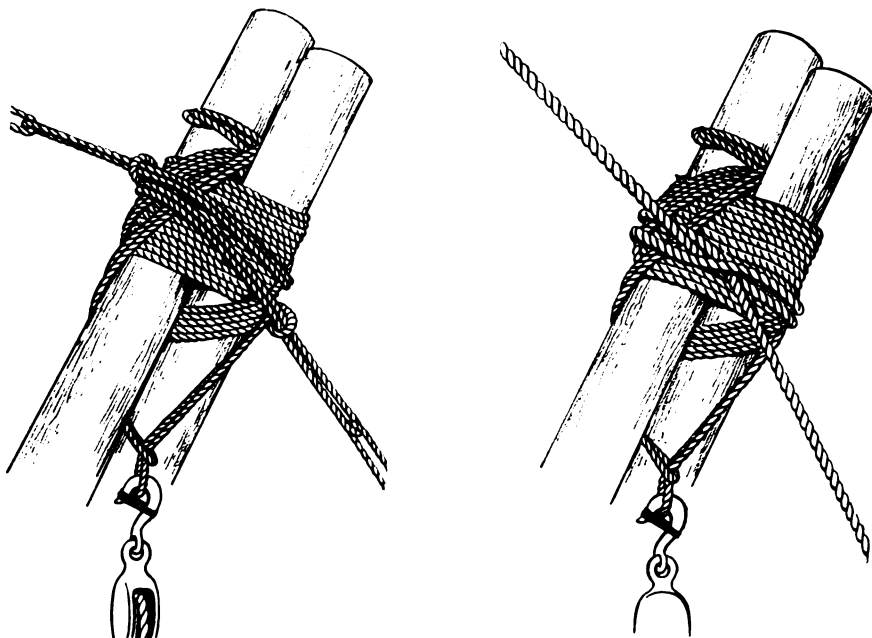


Fig. 154.—Head of sheers—methods of rigging

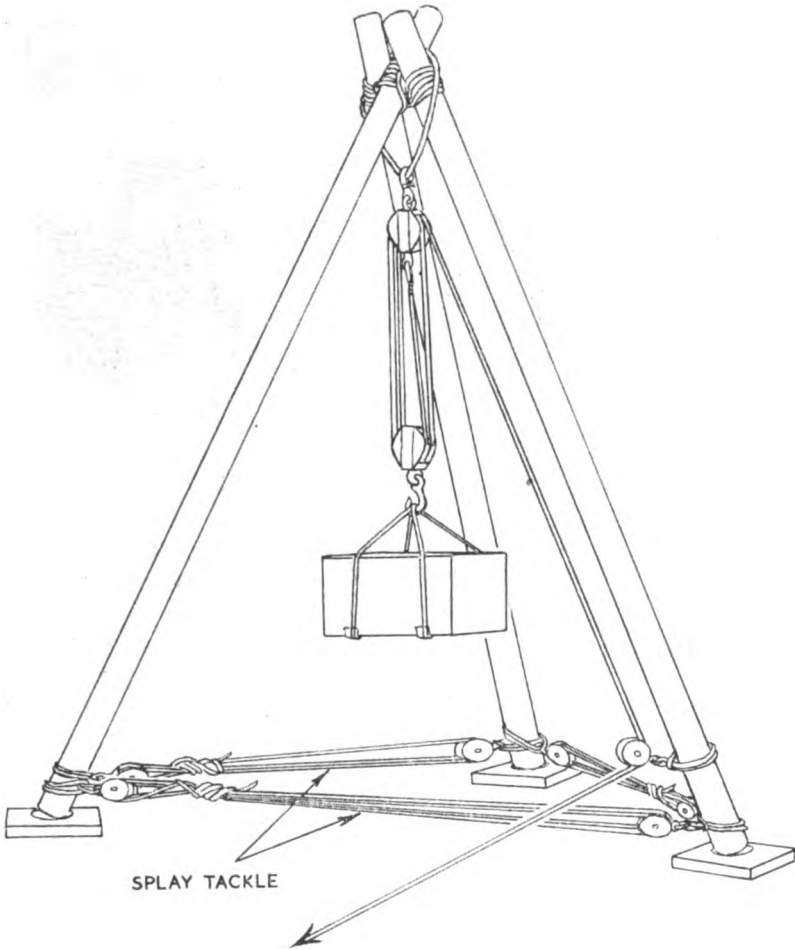


Fig. 155.—A gyn

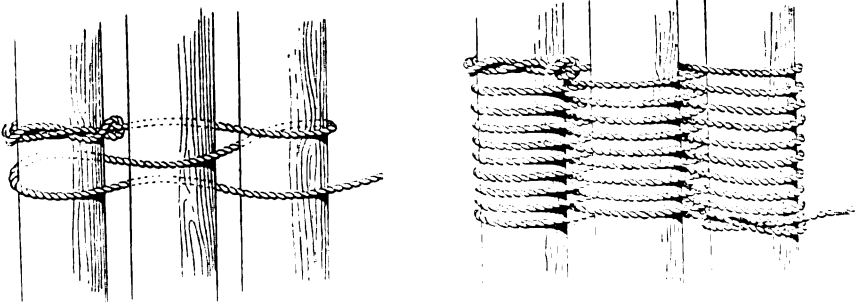


Fig. 156.—Passing the head lashing of a gyn

The topping lift and martingale, or fore and back guys, are then secured to the head of the sheers. There are several equally good ways of doing this, two of which are illustrated in Fig. 154, and in each of which the principles are that the pull of the guys should assist in binding the sheers together, and that the purchase strop should be free to take up its natural position as the weight comes on it.

The necessary tackles for the guys and other rigging are then shackled to the strops or clapped on to the ends of the ropes, as required, and finally a small block is attached to each leg above the cross and a single whip then rove through each to serve as gantlines for sending a man aloft to make any adjustments after the sheers have been raised. The rigging of the head of the sheers has now been completed.

The sheers are then placed roughly in position ready for raising, the heels being pointed to the shoes prepared for them and supported laterally by "splay" and "heel tackles". The distance between the shoes should be one-third of that from the foot of the sheers to the crutch and this latter distance is the effective length of the sheers.

As its name implies, the splay tackle leads from the heel of one spar to the heel of the other, being secured to each by a strop. The heel tackles guy the heels laterally and, as for a derrick, their strops should be kept as low down as possible.

The leading block for the fall of the purchase is then attached to one leg, and, after fitting thumb pieces or rope collars to prevent all the strops at the feet of the legs from slipping upwards, the sheers are now rigged and ready for raising.

TO RIG AN EXTEMPORE GYN (Figs. 155 and 156)

The position for the head lashing is first marked on all three spars which are to be used for the legs. These legs are then laid parallel with each other, an inch or two apart and with the heel of the centre leg pointing in the opposite direction to those of the other two. The marks must be in line and the heads of the legs should be supported clear of the deck.

The lashing is then put on at the marks. It is begun with a timber hitch round one leg, then from six to eight figure-of-eight turns are taken, as shown in Fig. 156, and the lashing is completed with a clove hitch round one leg. The lashing must be applied loosely; it cannot slip down once the gyn is erected, and if it is too taut great difficulty will be experienced in raising the gyn; it is usual, however, to place a rope collar round the odd leg below the lashing to prevent it slipping down during the process of raising.

The heels of the two legs which are lying close together are now opened out, and the splay tackles are rigged between the feet of each pair. The gyn is then raised by lifting its head and hauling the heel of the odd leg towards the other two by means of the splay tackles. When the head reaches a convenient height the strop for the upper block of the purchase is put on and the block itself secured to it. Then tackles are rigged as required to haul the feet into place on their shoes. When thus correctly placed the feet are secured by lashing or heel tackles led so as to give the necessary lateral support, and the hauling part of the purchase is led through a block secured to the heel of one leg.

As with derricks and sheers, thumb pieces or rope collars are required to prevent the strops at the heels from slipping up the legs. With very small gyns splay tackles are not necessary, and their feet can be manhandled into place and then secured, either by lashings or by short spars lashed across them.

STRENGTHS OF RIGGING FITTINGS AND GEAR

The "working load" of any fitting or gear is the maximum load it is designed to bear in practice, and is fixed as a definite proportion of the load at which it will break, known as the "breaking stress". The ratio of the working load to the breaking stress is called the "factor of safety", and gives a measure of the ability of the gear concerned to stand up to its work; the factor of safety is usually between four and eight.

All gear built up of individual units is itself designed for a definite working load, and it is vital that each unit of which it consists should be strong enough to withstand that load, otherwise the strength of the whole is weakened. Similarly, any unit that is unnecessarily strong will reduce the efficiency of the whole because of the unnecessary weight it adds to it. The working load of each part must therefore be not less than, and should be no more than, that of the whole system.

Before being accepted for the Royal Navy all but the most unimportant fittings are subjected to a proof load which they must bear without injury. The proof load also is based on the breaking stress, and normally has to be twice the working load. The proof test of some important fittings is repeated at intervals of one or two years, because, as described in the next paragraph, the strength of a metal object may deteriorate. After each test the fitting is subjected to a careful examination, and if it shows no signs of damage it is then stamped with the place, date, proof load and initials of the person responsible for testing it; a fitting marked CT, 10T. 2.4.46. AB. for example, would have been tested at Chatham to 10 tons on the 2nd April, 1946, by the person whose initials were AB.

Apart from normal wear and corrosion a metal fitting which is amply strong when new may become gradually weakened by induced brittleness, sometimes called "fatigue". Generally speaking fatigue is caused by suddenly applied loads, particularly if they are applied from alternate directions, and by sharp blows such as those caused by dropping the fitting or knocking it about. Continued ill-treatment in this manner will ultimately result in the cracking and fracture of the metal. Brittleness can be corrected by a heat treatment called "annealing" or "normalising", which restores the metal to its previous condition but will not repair any cracks that may have developed in it.

The factor of safety, and therefore the working load, are usually fixed by the designers with regard to the amount of wear and fatigue to which the fitting is likely to be subjected and to the proposed intervals between its proof tests; the less frequent the tests the higher must be the factor of safety. Allowance is also made for the fact that if a load is applied suddenly the gear is subjected momentarily to a stress which may be as much as twice that of its normal working load, and, as well as reducing the margin of safety, such stress causes fatigue; in addition, it should be noted that if a metal fitting is stressed beyond a certain limit (usually about half the breaking stress) it will be permanently distorted. The margin afforded by the factor of safety is therefore much less in practice than it appears to be.

Working loads of fittings used in the Royal Navy are fixed by the Admiralty, and, generally speaking, their factors of safety are greater than those assessed in commercial practice where lightness of gear, particularly for cargo work, is so important to efficiency. For example, the heavy derrick of many a well-found freighter will, when hoisting its full load, have parts of its gear stressed

well beyond the limits allowed by Admiralty practice, but because the derrick is carefully maintained and frequently inspected and tested this is quite acceptable.

Though normally no gear should ever be stressed beyond its working load, occasions do arise (such as in salvage work) where exceptional stresses must be accepted, and provided that the cost in additional wear and fatigue is duly counted, stresses which would be dangerous if continued as a regular practice can be very occasionally accepted. Generally speaking, the more recently any gear has been tested the less it has been used since the test, and the more the care with which it has been maintained the greater, within obvious limits, is the load to which it can be subjected. The correct assessment of the load it will bear and the risks involved in subjecting the gear to it requires good judgment based on knowledge of the foregoing principles and considerable experience.

All rigging items supplied to the Royal Navy are listed in the *Rate Book of Naval Stores*, and details can usually be found in the complementary numbered schedules which are small pamphlets published by the Director of Naval Construction; when included the appropriate schedule is shown alongside the letter C or D in the "Description" column on each page. For example, the heading "C 5 Smith's work" indicates that the gear shown below it is included in Schedule Number 5, which is the specification for smith's work. A selection of items used in rigging is given in the appendix to Volume III of this manual and listed so as to enable the gear to be matched for strength or size.

The various items can be described by their proof loads, sizes, or pattern numbers (*e.g.* 5-ton bow shackle, one-inch bow shackle, or bow shackle Patt. 5346). The method of measuring the size of each fitting, and other details are given below. The pattern number is always required when drawing gear from Naval Stores. It must be remembered that the proof load stamped on each fitting is double the working load; *in other words a 10-ton shackle is required for a 5-ton working load.*

The rules given for calculating the approximate working load of hooks, shackles, and similar fittings assume that they are made of the material quoted; fittings made of higher grade metal will, of course, be stronger.

SHACKLES

The size quoted for a straight or a bow-shaped shackle used with rigging is the diameter of the metal at the crown. The working load of a straight shackle is found from the formula $W = d^2 \times 4$, where W is the working load in tons and d the size in inches, and that of a bow-shaped shackle from $W = d^2 \times 2\frac{1}{2}$, or, if the size be less than half-inch, from $W = d^2 \times 2$. In this connection it should be remembered that the sizes quoted for shackles and other gear which form part of the outfit of anchors and cables are not their own measurements, but those of the cable for which they are designed. On completion of its manufacture each shackle is tested to the proof load laid down in its specification, and the maximum working load can be taken as being half this amount. The factor of safety in the great majority of shackles is 6.

THIMBLES

These can be made of iron or steel, but those used for wire rope are usually of steel; the pattern number is always stamped on each.

The size of a thimble is usually quoted as that of the rope for which it is designed, but this is complicated by the fact that a wire rope requires a snug

fit while most fibre ropes need a slack fit to allow room for the rope to swell, and so a larger thimble is used for fibre rope than for a wire rope of similar size. Fibre rope is also often actually larger than its standard size owing to the tolerance allowed in manufacture. The size of rope which a thimble will take depends on both the width and depth of the score, but a fair practical assumption is that, where d is the width of the score, it will be $d \times 3$ for wire rope, $d \times 2\frac{1}{2}$ for served wire rope, and somewhere between the two for fibre rope. Dimensions of thimbles supplied can be found from the *Rate Book of Naval Stores* and in the appendix to Volume III of this manual.

A thimble is properly described by its size and type (e.g. one-inch, heart-shaped, open, steel thimble); the pattern number should always be quoted when drawing one from Naval Stores.

As the strength of rigging or any other equipment is not affected by the strength of any thimble fitted in it, thimbles have no specified working load, but a steel thimble should not be distorted by a pull of up to $C^2 \div 2$ tons where C is the size in inches, and it will usually crush at about 50 per cent. above this load. Iron thimbles are not so strong, but they are adequate for fibre rope.

Note: The older patterns of thimble supplied to the Royal Navy (numbered 1918 to 1926) are made large enough to take a served wire rope, but new (1947) range (Patts. Nos. 5090-5095) are intended to fit the bare rope; to use a thimble from the new range on a served rope a size one inch larger than that of the rope will therefore be required.

Hooks

The quoted size of a hook is the diameter of the metal at its crown. The working load can be found approximately from the formula $W = d^2 \div 2$, where W is the working load in tons and d the diameter in inches of the *back* (not the crown) of the hook. The working load of hooks for boats' slings is nearly double the above.

All except minor, miscellaneous hooks, such as hammock hooks and can hooks, are tested after manufacture to a proof load laid down in their specification, and the working load is half the proof load. Hooks for boats' slings also have a failing load laid down for them, and a percentage are tested to destruction; their factor of safety is about $5\frac{1}{2}$.

EYE-PLATES

Stamped steel eye-plates are used for securing an eye to a metal structure; riveting is at present (1948) considered the more reliable method, the rivets being always stronger than the eye. It is Admiralty policy that welding should not be used for important eye-plates unless they can be tested in position. The size quoted for an eye-plate is the diameter of the metal forming its eye.

The working load is given approximately by the formula $W = 6 d^2$, where W is the working load in tons and d the size in inches.

After manufacture every eye-plate is tested to the proof load laid down in its specification, and the working load is taken as being half this amount. Its factor of safety is 4.

EYE-BOLTS

Wrought iron or mild steel eye-bolts are used for attaching eyes to a wooden structure; they are of two types, the "driven" and the "screwed." Driven eye-bolts are much the stronger and are used for any but the lightest loads; they

are drawn from store, double-ended, in pairs, and have to be cut and threaded as required. The size quoted for both types is the diameter of the metal composing the eye.

The working load of a driven eye-bolt is given approximately by the formula $W=5 d^2$, where W is the working load in tons and d the size in inches. The screwed eye-bolt has no specified strength because of its uncertain hold when screwed into wood.

Driven eye-bolts are tested after manufacture to the proof load laid down in their specifications, and the working load is fixed at one half this amount.

RING-BOLTS

A ring-bolt consists of a driven eye-bolt with a ring or link attached ; the metal forming the ring is of the same diameter as that of the eye-bolt, but the ring is much the weaker of the two. The working load of the ring-bolt is that of the ring, and is found from the formula $W=2 d^2$, where W is the working load in tons and d the size of the ring in inches.

On completion of manufacture each ring-bolt is tested to the proof load laid down in its specification, and the working load is taken as being half the proof load of the ring.

RINGS

The size quoted for a ring is the diameter of the metal, and the approximate working load of a wrought iron ring can be found from $W=2 d^2$, where W is the working load in tons and d the size in inches. This formula holds good for most rings supplied to the Royal Navy whose internal diameter in the clear is four times the diameter of the metal, but a more general formula is $W=d^3 \times 9 \div D$, where D is the mean diameter of the ring, and W and d are as before.

Each ring is tested after manufacture to the proof load given in its specification, and the working load is taken as being half this amount. Of those supplied for boats' slings a percentage are tested to destruction and must give a factor of safety of 6.

UNION PLATE

This is a metal plate through which three or four holes are drilled to enable the eyes of wire ropes or ends of chain to be shackled to it. The *Rate Book for Naval Stores* describes it as an "eye-plate", three-eyed or four-eyed, as the case may be, and a three-eyed union plate is sometimes called a "shamrock plate" or "monkey-face".

Union plates are tested after manufacture to the proof loads laid down in their specifications, and their working loads are taken as half these amounts.

RIGGING SCREWS

All rigging screws are tested after manufacture to the proof load laid down in their specifications ; working loads are taken as half this amount. Proof loads are given in the appendix to Volume III of this manual.

CHAIN

Chain is often used in rigging equipment, for the whips of cranes for example, where the chafe is considerable ; a list of suitable types is given in the *Rate Book*. Chain is described by its size, which is the diameter of the metal composing a link, and it has no pattern number. The formula for finding the approximate working load of chain is $W=5 d^2$, where W is the working load in tons and d the size of chain in inches.

Chain is tested after manufacture to the proof load laid down in its specification ; the working load is taken as being half this amount, but if chain is knocked about or subjected to shock (both of which should be avoided if possible) it must be annealed periodically, or it will part owing to fatigue.

SLIP FOR RIGGING

This small iron slip is supplied to the Royal Navy in various sizes for general purposes. The approximate working load in tons is $5d^2$, where d is the diameter in inches of the metal forming the link. These slips are tested to the proof load laid down in their specifications, and the maximum working load is taken as being half this amount.

BLOCKS

On completion of manufacture, alteration, or repair, every block is tested to the proof load which it must bear without injury. In addition, certain important blocks are tested periodically. The proof load depends on the designed strength of the block and is laid down in its specification ; the test is applied so that the crown of the block and the pin of the sheaves are subjected to this load. The record of each test is stamped on the crown of I.B. blocks, and on the shell or binding of common, clump, and metal blocks.

In the Royal Navy the safe lifting load of a block is the weight of hoist for which it can be used without being stressed beyond half its proof load, and without the working load of the rope or fall being exceeded. Nearly all blocks are much stronger than the rope for which they are designed, and thus the safe lifting load is nearly always limited by the working load of the fall. But the safe lifting load also depends on the way in which the block is used ; for example, the safe lifting load of a block used as the upper or standing block of a purchase will be different if it is used as the lower or moving block of the same purchase. With a few exceptions safe working loads of all blocks are worked out for the following uses :—

- (i) as a single whip (single blocks only) ;
- (ii) as the upper (standing) block of a hoisting purchase (except when a becket is not fitted) ;
- (iii) as a lower (moving) block of a hoisting purchase.

In these instances the purchase is assumed to be rove to disadvantage, that is with its hauling part coming from the upper block, because when so rove the blocks are subjected to the greatest load.

Snatch blocks have only one safe lifting load because they are single blocks. Common blocks below 10 inches in size, and all wooden clump blocks, are not stamped with a safe lifting load, but the strength of a clump block can generally be taken as being a quarter of the strength of an I.B. block used for the same size of rope. Blocks which form part of a complete lifting system, such as a derrick, are also not marked with a safe lifting load, because it might be greater than the working load of the whole system and thus lead to misunderstanding and accident. In such cases the safe working load of the entire system is shown on a tally plate in the vicinity.

In the Merchant Navy the various loads for blocks are laid down in the *Docks Regulations*. The safe working load is taken as being the maximum weight of hoist for which the block should be used, and takes no account of the strength of its fall ; it thus depends solely on the strength of the block and its employment. Proof loads are authorised as follows : single blocks—four times the safe working load ; multiple blocks with S.W.L. up to and including 20 tons

—twice the safe working load ; multiple blocks with S.W.L. over 20 and up to and including 40 tons—20 tons in excess of the safe working load ; multiple blocks with S.W.L. over 40 tons—one-and-a-half times the safe working load. It will thus be seen that under the *Docks Regulations* a block is proved to a stress of from one-and-a-half to four times the maximum load it will bear in ordinary working.

In addition to their proof loads, blocks used in the Royal Navy are marked with the following information : pattern number, maker's name, year of manufacture, size of cordage or wire rope for which the block is designed, and safe lifting load. Common and clump blocks are marked with their size instead of a pattern number. The maker's name and year of manufacture of I.B. blocks are marked on the binding ; with this exception all this information should be visible on the sides or crown of a block.

The *Docks Regulations* prescribe that all blocks used in the Merchant Navy for hoisting or lowering must have their safe working loads marked on them.

Where modern I.B. or steel blocks are used the standing part of the fall is secured to the metal becket provided for the purpose. With old fashioned blocks it is sometimes spliced round the strop at the tail of the block, but a much better and stronger method is to splice it round the eye at the crown and seize the bight into the tail.

Strops used for common and clump blocks are of wire rope and are parcelled and served. They can be put on singly or on the bight (*i.e.* as a single or as a double strop), and so that the thimble lies at right angles to the sheave or in line with it. The correct length for a single strop is once round the block, once round the thimble, and once round the rope ; and for a double strop it is twice this amount.

In the Royal Navy 10-inch and 11-inch clump blocks have double strops made of $1\frac{1}{2}$ -inch wire rope joined with a short splice. For 12-inch and 13-inch clump blocks $1\frac{1}{2}$ -inch wire rope is used.

Common blocks up to 11 inches in size are stropped with three-parted wire grommets, but four-parted grommets are used for 12-inch blocks and above. The size of the strand required for the grommets of blocks of different sizes is given in the following table.

<i>Size of Block</i>	<i>Size of Strand</i>
3-inch	$\frac{3}{4}$ -inch
4-inch	$1\frac{1}{2}$ -inch
5-inch	$1\frac{1}{2}$ -inch
6-inch	2-inch
8-inch	$2\frac{1}{2}$ -inch
9-inch	3-inch
10-inch	3-inch
11-inch	$3\frac{1}{2}$ -inch
12-inch	$3\frac{1}{2}$ -inch
13-inch	$3\frac{1}{2}$ -inch

A great deal of time, trouble and temper will be saved if the pins of blocks, other than those with self-lubricating sheaves, are knocked out once every three months so that the bearings can be cleaned and oiled. Roller bearings, where fitted, are fixed in the sheave and can be plainly seen when the sheave is removed. They should be examined and filled with grease.

Blocks which squeak and scream in use are said to "complain"; a good seaman sees that his blocks never complain.

PURCHASES AND TACKLES

The stresses on the standing, running and hauling parts of the fall of a tackle depend to a certain extent upon the friction in the sheaves and in the running part of the fall. The amount of this friction will in turn depend upon the size of the fall and the sheaves, the number of sheaves in the tackle, whether the tackle is rove to advantage or disadvantage, and whether it is being used for hoisting, lowering, or holding a load.

The rough rule for estimating the amount of friction set up in a tackle when hoisting a given weight is to allow one-tenth of the weight for every sheave in the tackle; thus if one ton is to be lifted and there are six sheaves in the tackle, the total friction will amount to six-tenths of a ton, or 12 cwt.

The pull required on the hauling part of a tackle to lift a given weight can be roughly estimated from the formula:

$$P.V. = \frac{W(10+N)}{10}$$

where:—P is the pull on the hauling part, V the velocity ratio, W the weight hoisted, and N the number of sheaves in the tackle.

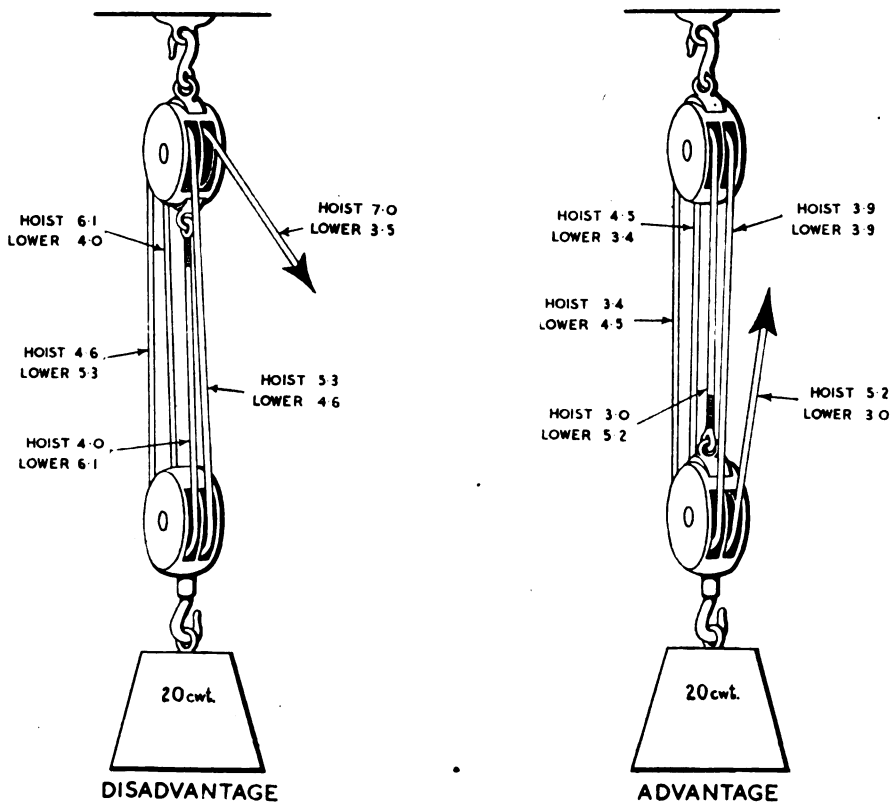


Fig. 157.—Load on each part of a two-fold purchase when hoisting and lowering 20 cwt.

Friction, however, occurs at the bearings of each sheave, and each part of the fall will bear a different proportion of the load and so be differently stressed.

When hoisting, the hauling part takes the greatest load and is the most highly stressed, the standing part is the least stressed, and the stresses in the other parts are progressive between these two extremes ; when lowering this situation is reversed, because the standing part takes the greatest load. When a tackle is holding a load still, the stress in each part will be between those to which they are subjected when hoisting or lowering.

These effects of friction are given in the table below, which gives the loads which can be hoisted and held by various tackles when their hauling parts are subjected to a pull of 10 cwt. ; they are also illustrated in Fig. 157, which shows the load on each part of a two-fold purchase in average condition when hoisting and lowering 20 cwt.

TACKLE	SINGLE WHIP	DOUBLE WHIP	LUFF (all rove to disadvantage)	TWO-FOLD	THREE-FOLD
No. of parts in moving block	—	2	3	4	6
Load hoisted, cwt.	8½	16½	23	28½	38
Load held, cwt.	11½	24½	40	57½	100

As blocks are stronger than the ropes for which they are designed the maximum working load of a purchase is that of its fall. It can be calculated from the table given below, or, for a purchase rove to disadvantage, it can be obtained by taking the appropriate safe lifting load from each block and using whichever is the less. The figures in the table are based on a maximum pull on the hauling part of approximately one-eighth of the breaking stress of new manila. The blocks are assumed to be in good condition.

TACKLE	SAFE WORKING LOAD IN TONS	
	<i>Rove to Advantage</i>	<i>Rove to Disadvantage</i>
Single Whip	—	C² 24
Guntackle or Double Whip	C² 7½	C² 12½
Luff	C² 6	C² 9
Two-fold purchase	C² 5	C² 7
Three-fold purchase	C² 4	C² 5½

C=circumference of the fall in inches

Experienced seamen working with good gear may, if necessary, exceed the above working loads, but others should not do so.

Provided that the working load of no part of the gear is exceeded, a given mechanical advantage is obtained more efficiently by a combination of two small tackles than by one large one, because there are then fewer sheaves to cause loss by friction and the smaller tackles are lighter and much more easily handled.

A single part of rope when used for hoisting tends to untwist and cause its load to spin ; in the same way a rope rove through a block will, when under load, spin the block and put turns in the parts of the tackle. One such turn in the parts will increase the pull required on the hauling part of a tackle by about 40 per cent., and two or more turns will increase it immeasurably. This tendency of the block to spin can be countered by thoroughfooting the fall before reeving the tackle, or by the use of anti-twisters, or, in a two or three-fold purchase, by reeving the fall so that the sheaves will turn in opposite directions.

The simplest form of anti-twister is a handspike placed between the parts, close up to the block. If the block is out of reach and the tackle is being used horizontally the handle of a heavy mallet or sledge-hammer can be lashed across the crown of the block, and the weight of the head will then prevent the block from twisting. When this method is unsuitable a handspike can be lashed across the crown and secured by lines made fast to its ends.

The following method of reeving a three-fold purchase not only helps to prevent turns forming in the tackle, but, because the hauling part comes away from the centre sheave, avoids a tendency for the block to cant as the load comes on it.

Let the block to which the standing part will be secured be called A, and the other, B. Both should be laid tail to tail, A being on its edge with the sheaves vertical, and B on its cheek ; the fall is then rove as follows :—

- (i) down through the centre sheave of A ;
- (ii) from right to left through the lower sheave of B ;
- (iii) up through the left-hand sheave of A ;
- (iv) from left to right through the upper sheave of B ;
- (v) down through the right-hand sheave of A ;
- (vi) from right to left through the centre sheave of B ; and
- (vii) finally secured to the becket of A.

A two-fold purchase can be similarly rove, but this is not often necessary. The blocks are laid as before and, assuming that the becket of A happens to be on the right hand side, the fall is rove as follows :—

- (i) down through the right hand sheave of A ;
- (ii) from right to left through the lower sheave of B ;
- (iii) up through the left hand sheave of A ;
- (iv) from left to right through the upper sheave of B : and
- (v) finally secured to the becket of A.

Had the becket been on the left side of the block A the fall would be rove in the reverse manner to that described.

SPECIAL PURCHASES

The rule given on page 226 for finding the pull required on the hauling part of a tackle to lift a given weight is based on the friction found by actual experiment to occur in ordinary upper deck tackles, but it is not applicable to special purchases such as the topping lift and purchase of a heavy derrick. In

such special purchases, which may be three, four or five-fold, friction has to be reduced to a minimum or they will not be able to lift their designed working loads efficiently and in safety; their blocks are therefore of special design and have to be very carefully maintained and oiled.

In the rule quoted above the allowance for loss of efficiency due to friction was ten per cent. of the weight being hoisted for each sheave in the tackle. This loss decreases with improved design and maintenance of the blocks, and in a large, special purchase is reduced to 5 per cent. or less; therefore, when considering its mechanical advantage, the following formulae should be used:—

$$M = \frac{V}{1 + \frac{n}{20}}, \text{ and } P = \frac{W (1 + \frac{n}{20})}{V}$$

where

M = mechanical advantage of the purchase ;

n = number of sheaves in the system ;

P = pull on the hauling part ;

V = velocity ratio of the purchase ;

W = weight to be hoisted.

GEARED BLOCKS

Geared blocks are mechanical purchases designed for lifting weights and have a number of advantages over the simple tackle. They usually consist of a driving sprocket, worked by an endless hand chain, which operates the load sprocket through some type of gearing; the load sprocket carries the load chain to which the hoisting hook is attached. In mechanical purchases supplied for use in confined spaces the endless chain is replaced by a lever and ratchet.

Geared blocks can be designed with a very large mechanical advantage and the loss in them by friction is small; the full working load of the gear can therefore usually be raised by one man. Blocks supplied to the Royal Navy have working loads of from a quarter of a ton to as much as 15 tons, but those of over 3 tons working load are not widely used. The mechanical advantage of the lever and ratchet purchase depends on the length of the lever, and the working load is therefore limited. Geared blocks are supplied with chain sufficient for a lift of 10 feet, and the lever type of purchase can raise its load between 5 and 6 feet.

All of these purchases are self-holding, *i.e.* the load remains suspended when the operating hand chain or lever is released, but certain types are fitted with a gravity lowering device which enables the load to be lowered by its own weight, under control, at a steady speed of 25–30 feet per minute.

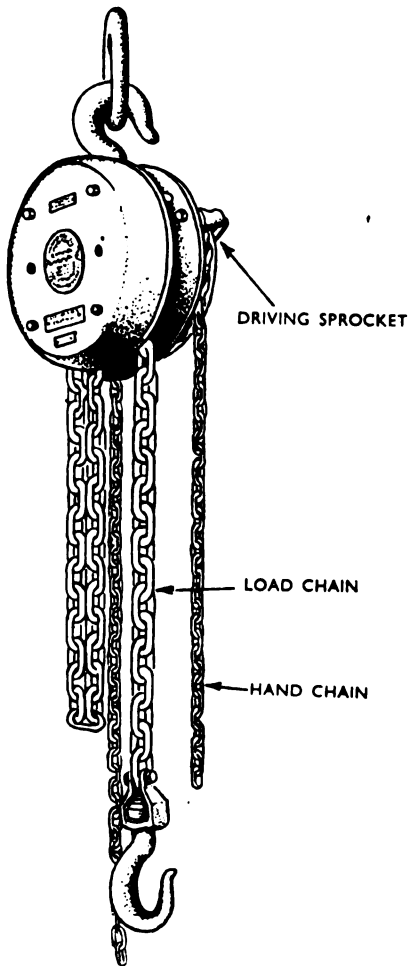
Geared blocks running on overhead rails are used for transporting torpedoes. Those which are required to negotiate curves have their rollers mounted on bogies, and some can be traversed along the rails by operating a second hand chain and sprocket wheel, which device is called geared traversing.

A complete list of geared blocks supplied to the Royal Navy, together with the lever and ratchet purchases, is given in the *Rate Book of Naval Stores*.

DETAILS OF GEARED BLOCKS

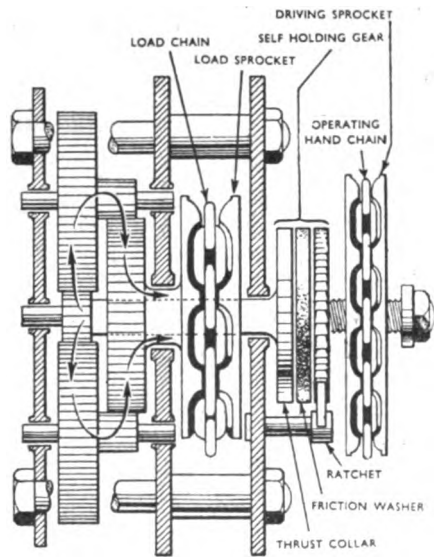
These blocks vary in design, but are grouped into the three main classes described here.

(i) *Spur Geared Blocks* which obtain their mechanical advantage through various systems in which small pinions drive large toothed gear wheels. The loss due to friction is as small as from 5 to 10 per cent., which compares with the 37 per cent. lost in an upper deck three-fold purchase.



(i)

There being so little friction, some device such as that shown in Fig. 158 (ii) is necessary to make the gear self-holding. In the device illustrated the driving sprocket wheel is fitted on a screw thread cut in the end of its spindle, along which it moves out and in as it is rotated one way or the other. The ratchet wheel is free on the spindle, but as it is fitted with a pawl, it can



PLAN VIEW

(ii)

Fig. 158.—A spur-gear block

revolve only in the hoisting direction. The thrust collar is made in one piece with the spindle.

When revolved in the hoisting direction the sprocket moves along its screw thread until it comes up against the ratchet wheel. This, in turn, is squeezed against the friction washer and thrust collar so that the whole assembly revolves together.

When no longer being hoisted the load is held by the pawl and by the friction between the ratchet wheel and the thrust collar.

When the sprocket wheel is turned in the lowering direction it moves away from the ratchet, and the thrust collar being thus freed from the ratchet wheel the load descends by its own weight until the spindle has revolved a similar amount and thus again brings the sprocket wheel hard up against the ratchet.

(ii) *Blocks worked by a worm and wormwheel* in which one revolution of the worm moves the wheel one tooth, and therefore the mechanical advantage can be measured by the number of teeth in the wormwheel less a small allowance for friction.

A worm and wormwheel can be designed to be automatically self-holding, but the worm must then be inconveniently large for a geared block; the small worm used in geared blocks is not self-holding and it is therefore necessary to incorporate a device similar to that used with the spur geared blocks.

In this form of purchase the driving sprocket is fixed to the worm spindle, as in Fig. 159 (ii). Rotation in the hoisting direction forces the worm to the left and jams the ratchet and friction washers against the cap, so that all then revolve together.

When at rest the weight hanging from the load sprocket wheel still forces the spindle hard to the left; the ratchet is then held by its pawl, and the friction between the ratchet and thrust collar makes the gear self-holding.

Rotation of the driving sprocket in the lowering direction moves the spindle over to the right; this releases the friction gear so that the load can be lowered.

An alternative self-holding gear is illustrated in Fig. 160, and consists of a disc, one side of which takes up against the driving sprocket so that it forms a frictional brake. This disc has wedges on its other side which engage with corresponding wedges attached to the shell of the block. The sprocket is fixed to the driving spindle but the disc is free.

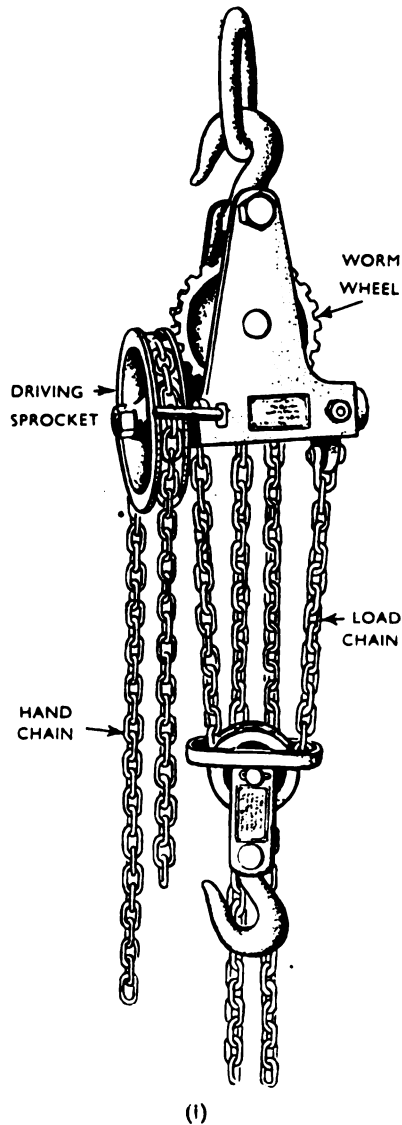
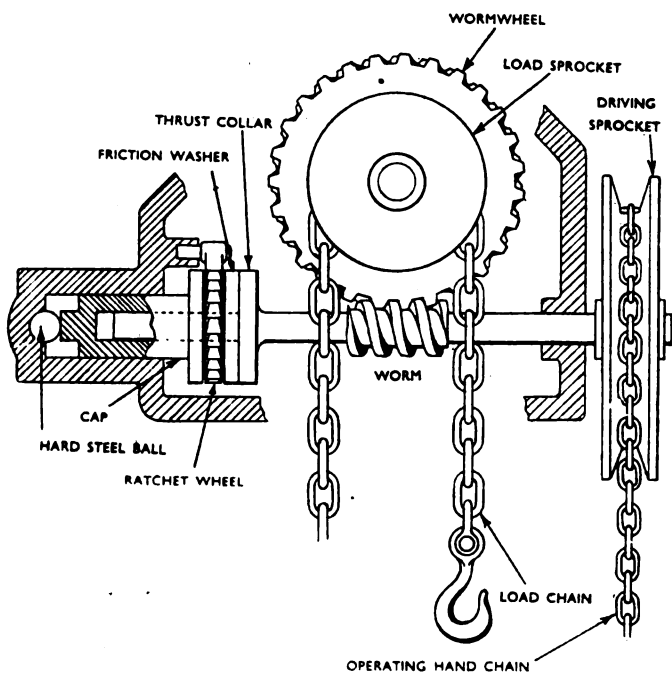


Fig. 159.—A worm and worm-wheel block



(ii)

Fig. 159 (contd.)—A worm and worm-wheel block

Movement of the sprocket in the hoisting direction forces the spindle to the left and so pulls the sprocket up against the disc, and the wedges then tend to release each other so that the brake does not bind.

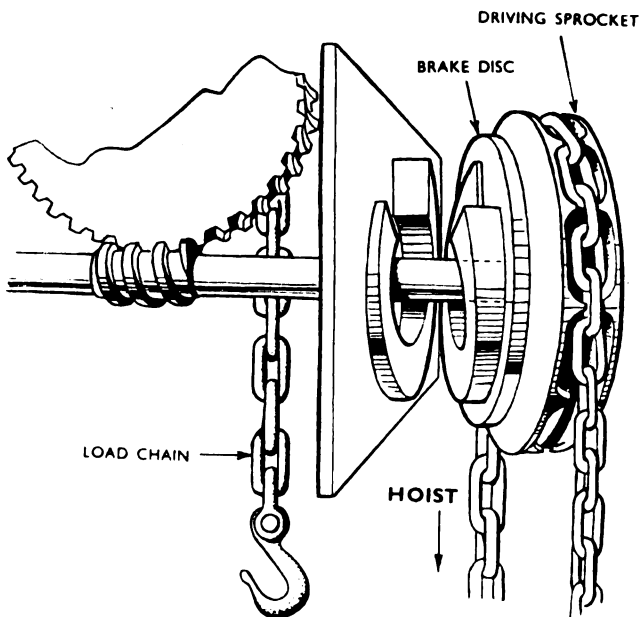


Fig. 160.—Alternative self-holding gear for a worm and worm-wheel block

When hoisting ceases the spindle is still forced to the left, but should the load take charge and tend to run back the wedges jam the disc and sprocket hard together, thus making the gear self-holding.

Movement of the driving sprocket in the lowering direction moves the spindle to the right, thus releasing the brake.

Blocks fitted with gravity lowering device are all of the worm and wormwheel type. The driving sprocket can be either keyed to, or freed from, the worm spindle by means of a clutch.

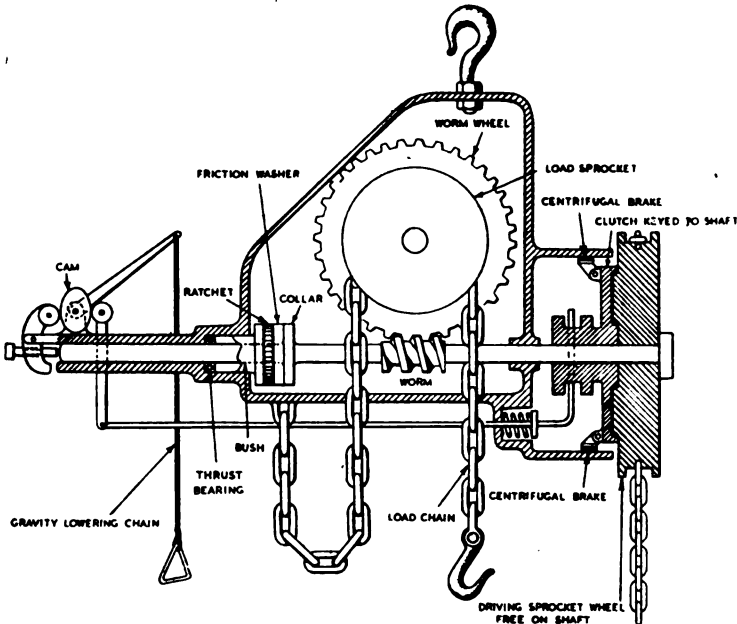


Fig. 161.—A worm and worm-wheel block fitted with gravity lowering device

As can be seen from Fig. 161 the worm spindle protrudes through the self-holding gear, and a loose bush and thrust bearing have been incorporated.

This device has the dual purpose of unclutching the driving sprocket and of forcing the spindle to the right so that the frictional self-holding gear is released.

The load is then free to lower and its rate of lowering is governed by a centrifugal brake incorporated in the clutch.

(iii) *The Lever and Ratchet Purchase* (Fig. 162), in which the mechanical advantage is gained by a simple lever worked after the fashion of a pump handle. When thus working the lever a pawl mounted on it revolves a ratchet wheel, and the pawl can be reversed so that the wheel can be turned in either direction. The ratchet wheel is fitted on a screw thread cut in the spindle of the load sprocket, and it drives this spindle through a self-holding gear similar in operation to that of spur geared blocks.

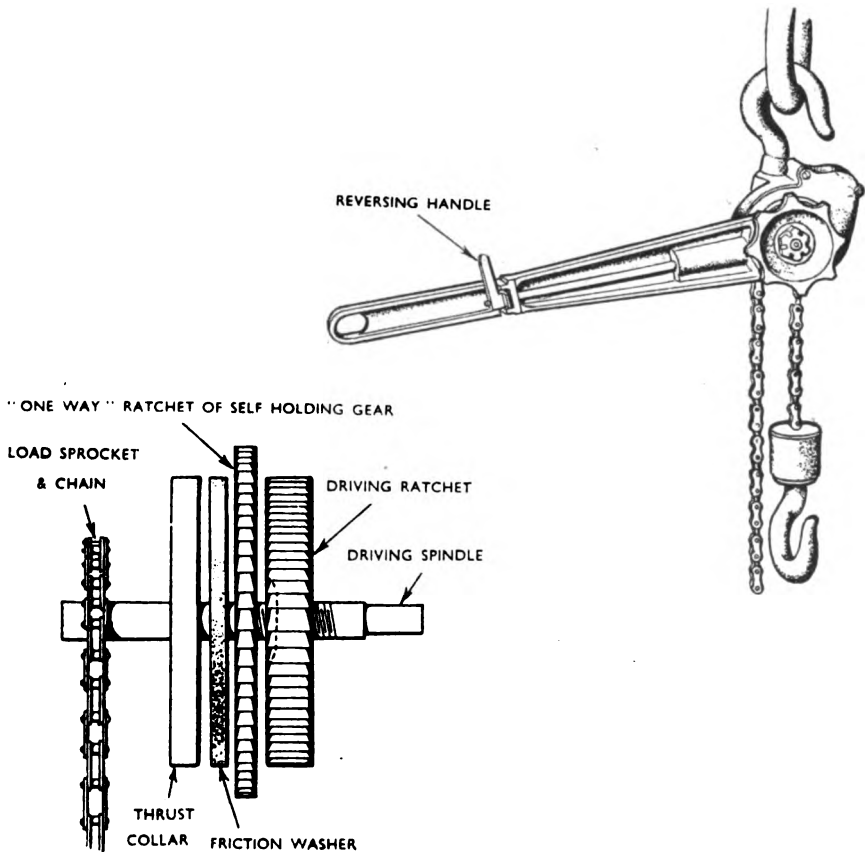


Fig. 162.—A lever and ratchet purchase

ESTIMATION OF STRESSES

Triangle of Forces

The stresses to which a derrick and its rigging or fittings may be subjected when supporting a load can be estimated approximately and very simply by the diagrammatic method known as the "triangle of forces".

The principles upon which this method is based can be stated as follows :—

(i) If the magnitude and direction of a force are known it can be represented by a straight line, called a "vector", the length of which indicates its magnitude and the direction of which, denoted by an arrow, gives the direction in which the force acts.

(ii) If three forces acting at a point are in equilibrium, and the vectors representing them are drawn end to end so that the directions in which they act are maintained, *i.e.* so that the arrows follow one another, they will form the three sides of a triangle.

(iii) If three forces acting at a point are in equilibrium and the magnitude and direction of only two of them are known, the magnitude and direction of the unknown force can be found as follows :—

Draw the vectors of the known forces end to end so that the arrows follow one another. Complete the triangle. The third side will

then represent the unknown force in magnitude and direction, the arrow pointing from the head of the second vector to the foot of the first.

(iv) When three forces acting at a point are in equilibrium, if the magnitude and direction of one force and the direction only of the other two are known, the magnitude of these two unknown forces can also be found by drawing a triangle of forces.

For three forces in equilibrium the arrows denoting the directions of the vectors always follow one another round a triangle of forces.

If more than three forces in equilibrium and acting at a point are involved, the same principles apply. The resulting figure, whose sides represent these forces, is then known as a "polygon of forces".

The following two examples show the application of this method for finding the approximate stresses in masts, derricks, and their rigging and fittings. In the examples it is assumed that the systems and their loads are at rest, and the effects of any friction are disregarded.

Example 1 (Fig. 163). A derrick is topped at an angle of 45° with the horizontal and is supporting a weight of 5 tons hung on the end of its whip. Find the magnitude and direction of the tension in the strop of the head block.

The tensions in the running and hauling parts of the whip are the same, namely 5 tons, so by drawing a triangle of forces based on the block A the tension in the strop AE and the direction in which it acts can be found in the following manner.

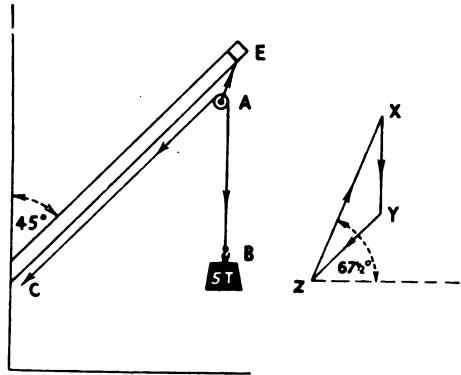


Fig. 163.—Estimation of stresses by triangle of forces—Example I

To a scale of one inch to 10 tons draw the vector XY, one inch in length, to represent the vertical downward pull of the weight on the running part of the whip, and on it mark its arrow, pointing downwards. From the point Y draw another vector YZ, parallel with AC and $\frac{1}{2}$ -inch in length, to represent the downward tension in the hauling part of the whip, and on it mark its arrow, also pointing in a downward direction. Complete the triangle by joining Z to X with a straight line and on it mark an arrow in an upward direction so that the arrows of the three sides follow each other round the triangle. Then :—

ZX is the vector representing the tension, both in magnitude and direction, in the strop AE of the head block, and when measured it will be found to be approximately 0.95 inches, representing a tension of $9\frac{1}{2}$ tons acting upwards at an angle of $67\frac{1}{2}^\circ$ with the horizontal.

Example 2 (Fig. 164). A span is rigged between two masts and a weight of 10 tons is hung on it so that the left leg of the span makes an angle of 45° with its mast, and the right leg of the span makes an angle of 65° with its mast. Find the pull on each of the shackles which join the span to the masts.

The pull on the shackles will be equal and opposite to the tensions in the respective legs of the span, and these tensions are found by considering the forces acting at the point C, where the magnitude and direction of the pull of the weight on the span are known, *i.e.* 10 tons vertically downwards, and the directions of the tensions in the legs of the span are known, *i.e.* upwards at angles of 45° and 65° respectively with the perpendicular.

To a scale of one inch to 10 tons draw the vector XY, one inch in length, to represent the vertical downward pull of the weight, and on it mark its arrow, pointing downwards. From the point Y draw a line parallel with CB and on it mark an arrow to represent the direction of the upward tension in the right leg of the span. From the point X draw a line parallel with AC so that it cuts the preceding line at Z, and on it mark an arrow to represent the direction of the upward tension in the left leg of the span. Note that the arrows follow each other round the sides of the triangle.

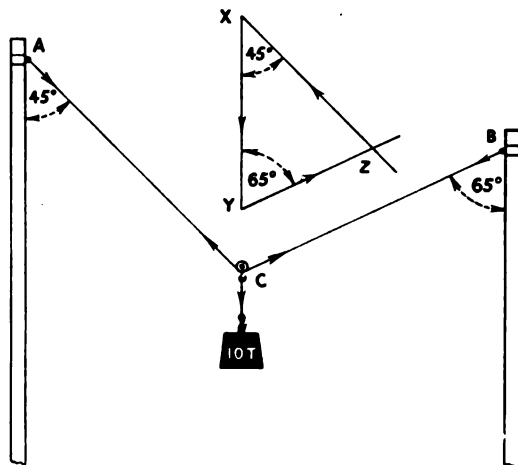


Fig. 164.—Estimation of stresses by triangle of forces—Example II

Note that the arrows follow each other round the sides of the triangle. Then :—

YZ is the vector representing the tension in the right leg of the span, which will be found to be 0.75 inches long (approximately) representing a force of $7\frac{1}{2}$ tons ; and

ZX is the vector representing the tension in the left leg of the span, which will be found to be one inch long (approximately), representing a force of 10 tons.

The approximate pulls on the shackles at A and B will therefore be 10 tons and $7\frac{1}{2}$ tons respectively.

In a similar manner the stresses on other parts or fittings of a mast and a derrick, such as the tension in the topping lift and the thrust in the derrick, can be found if the magnitude and direction of two of the three forces involved are known, or if the magnitude and direction of one force and the direction of the other two forces are known. Care should be taken when determining the direction in which a force acts ; for example, when considering the stresses at the derrick head the tension in the topping lift of a derrick will be acting in a direction from the head of the derrick towards the mast, but when considering the stresses at the masthead fitting it will be acting in the reverse direction.

Modification of Stresses

The stresses on certain parts or fittings of a derrick can be considerably modified by altering the rig. This is sometimes necessary if the derrick is to be used to hoist more than its safe working load, or when a fitting has to be replaced by one lacking the required strength.

By fitting a double whip, or a purchase instead of a single whip, or by leading the whip to the masthead, the loads on the various parts of the derrick can be considerably reduced. This is shown in the following three examples in each of which the derrick is 25 feet long, the topping lift is 20 feet above the heel of the derrick, the span of the topping lift is 18 feet, and the weight supported by the derrick is 10 tons. The "triangle of forces" method has been employed to show the manner of its use, and the weight of the derrick and its fittings and the effect of friction have been disregarded. The scale of the diagrams below is only very approximate.

(i) *Single Whip* (Fig. 165). The load on the head block shackle (AF) is found by drawing the triangle G H J, in which G H (parallel with A E) equals H J (parallel with AD), each equal to 10 tons, and J G represents the magnitude and direction of the pull A F, equivalent to $17\frac{1}{2}$ tons

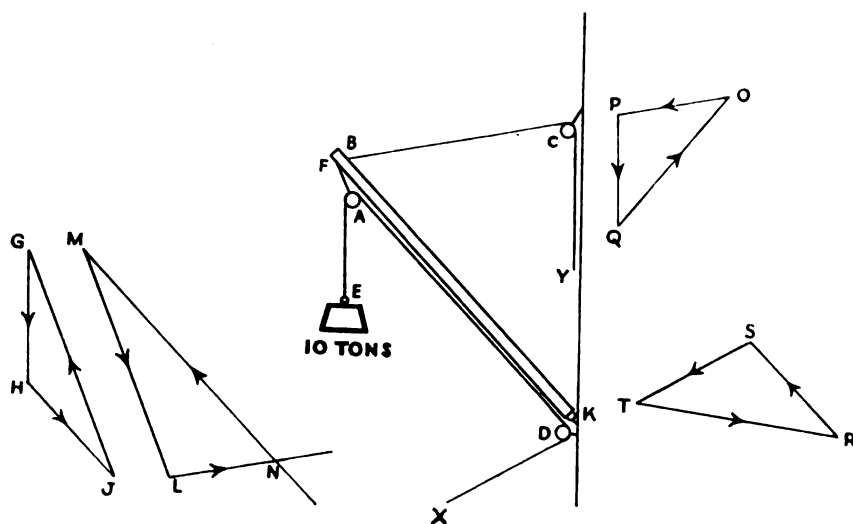


Fig. 165.—Stresses in a single-whip rig (approx. scale: 0·7 in. = 10 ton)

The tension in the topping lift (BC) and the thrust in the derrick (BK) are found by drawing the triangle L M N, in which M L is equal to and parallel with J G, L N is parallel with B C, and M N is parallel with B K. L N represents the tension in the topping lift, equivalent to 9 tons, and N M represents the thrust in the derrick, equivalent to $22\frac{1}{2}$ tons.

The load on the topping lift leading block (C) is found by drawing the triangle O P Q, in which O P (parallel with L N) equals P Q (parallel with C Y), each equal to 9 tons, and Q O represents the magnitude and direction of the load on the block shackle, equivalent to $13\frac{3}{4}$ tons.

The load on the whip leading block D is found by drawing the triangle R S T, in which R S (parallel with A D) equals S T (parallel with D X), each equal to 10 tons, and T R represents the magnitude and direction of the load on the block shackle, equivalent to 15 tons.

(ii) *Double Whip* (Fig. 166). The various triangles are drawn in a similar manner to that for the single whip, and from them the following forces are found :—

load on head block (J G), equivalent to 14 tons ;
 tension in topping lift (L N), equivalent to 9 tons ;
 thrust in derrick (N M), equivalent to $17\frac{1}{2}$ tons ;
 load on topping lift leading block (Q O), equivalent to $13\frac{1}{2}$ tons ;
 load on whip leading block (T R) equivalent to $7\frac{1}{2}$ tons.

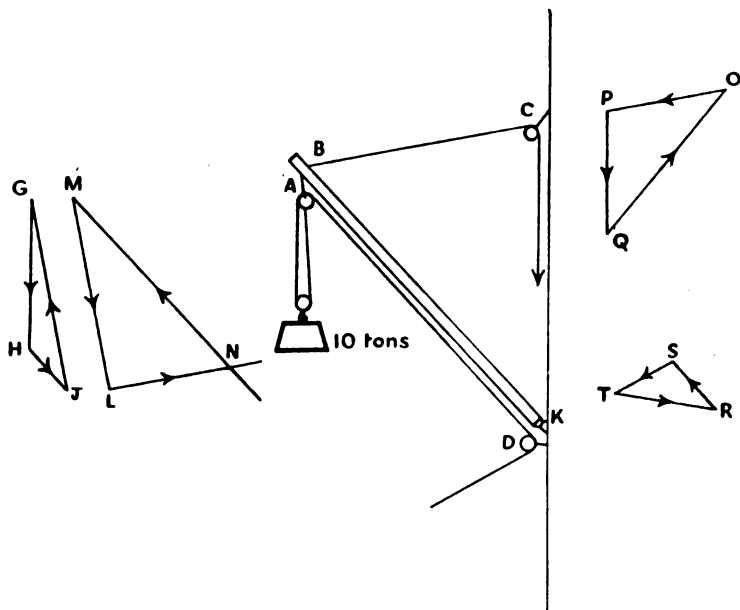


Fig. 166.—Stresses in a double-whip rig (approx. scale: 0·8 in. = 10 ton)

(iii) *Double Whip Led Through Masthead Leading Block* (Fig. 167). The various triangles are drawn in a similar manner to that for the single and double whips, and from them the following forces are found :—

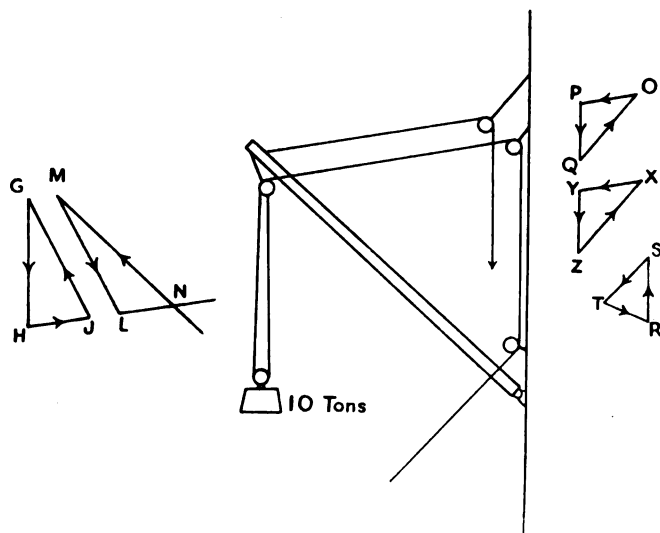


Fig. 167.—Stresses in a double-whip rig led to the masthead (approx. scale: 0·7 in. = 10 ton)

load on head block (J G), equivalent to $10\frac{1}{2}$ tons ;
 tension in topping lift (L N), equivalent to $3\frac{3}{4}$ tons ;
 thrust in derrick (N M), equivalent to $12\frac{1}{2}$ tons ;
 load on topping lift leading block (Q O), equivalent to 6 tons ;
 load on lower whip leading block (T R), equivalent to $4\frac{1}{2}$ tons ;
 load on upper whip leading block (Z X), equivalent to 8 tons.

The forces involved in the three types of rig illustrated in the three examples can be compared in the following tabular statement, which clearly shows the advantages to be gained by modifying the rig.

	SINGLE WHIP	DOUBLE WHIP	DOUBLE WHIP WITH HAULING PART LED ALOFT
Load on head block	$17\frac{1}{2}$ tons	14 tons	$10\frac{1}{2}$ tons
Tension in topping lift	9 tons	9 tons	$3\frac{3}{4}$ tons
Load on lower whip leading block	15 tons	$7\frac{1}{2}$ tons	$4\frac{1}{2}$ tons
Load on topping lift leading block	$13\frac{3}{4}$ tons	$13\frac{3}{4}$ tons	6 tons
Load on upper whip leading block	—	—	8 tons
Thrust in derrick	$22\frac{1}{2}$ tons	$17\frac{1}{2}$ tons	$12\frac{1}{2}$ tons

Lead of Topping Lift and Angle of Derrick

The lead of the topping lift is important. Fig. 168 (i) shows a 30-foot derrick with a 20-foot standing topping lift led to a point on the mast 20 feet above the heel of the derrick. When supporting a weight of 5 tons the tension in the

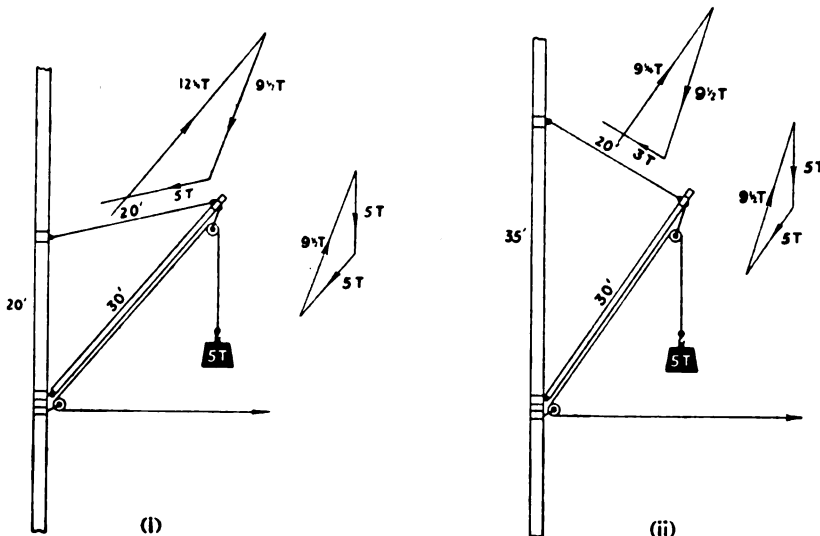


Fig. 168.—Lead of topping lift

topping lift is 5 tons and the thrust in the derrick is $12\frac{1}{4}$ tons. If, however, the topping lift is led to a point 35 feet above the heel (Fig. 168 (ii)) the tension in the topping lift is reduced to 3 tons, and the thrust in the derrick is reduced to $9\frac{1}{4}$ tons.

The angle at which the derrick is topped also has a bearing on the tension in the topping lift, but not on the thrust in the derrick. Fig. 169 (i) shows a 30-foot derrick topped at an angle of 30° with the mast by a working topping lift led to a point on the mast 30 feet above the heel of the derrick. When supporting a weight of 5 tons the tension in the topping lift is $2\frac{1}{2}$ tons, and the thrust in the derrick is 10 tons. If, however, the derrick is lowered to an angle of 60° with the mast the thrust in the derrick remains the same, but the tension in the topping lift is increased to 5 tons.

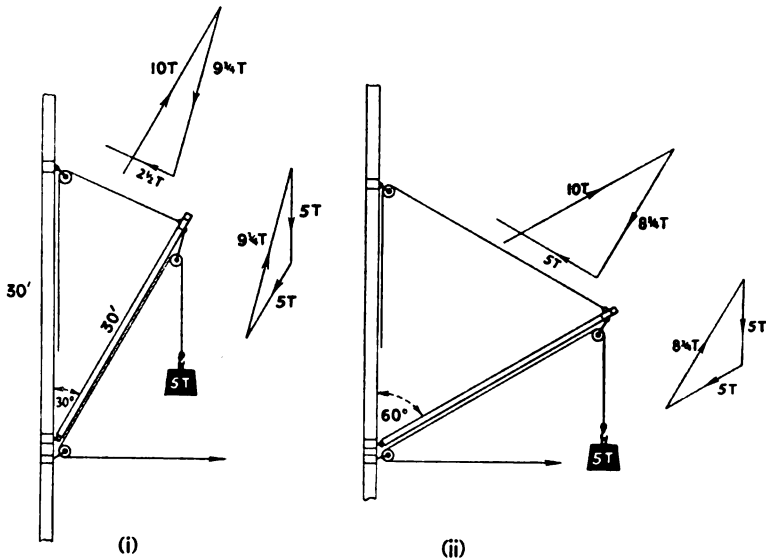


Fig. 169.—Angle of derrick

Precautions when working Derricks and Cranes.

Preventers in the form of standing topping lifts and guys may be fitted to derricks to confine their movement in the vertical and horizontal planes within those arcs in which the derrick is designed to carry its safe working load. Such derricks should not be worked outside these safe arcs unless special precautions are taken to strengthen the mast and derrick.

A mast or a derrick can be strengthened by binding stout battens or staves tightly around its centre portion over about two-thirds of its total length in the manner used to fish a broken spar (see page 181). A mast can be strengthened against buckling stresses by fitting it with extra stays; masts carrying jumbo derricks are provided with such stays, and these must always be fitted and set up before the jumbo derrick is used.

A derrick should never be worked when drooped at an angle below the horizontal.

When derricks or cranes are used to hoist boats it should be borne in mind that the lifting weight of the boat shown on pages 349 and 352 does not include any water which may be in the boat's bilges or any extra equipment or fittings which she may be carrying. When, therefore, the specified weight of the boat is nearly equal to the working load of the derrick or crane these factors must be taken into account to ensure that the working load at the specified radius is not exceeded.

CHAPTER VII

Boatwork

INSTRUCTION IN BOAT PULLING

THE following notes on instruction in boat pulling are given as a general guide to instructors. The principles of pulling are applicable to any type of boat, but there are certain minor differences in drill for single and double banked boats.

Manning the Boat

It is assumed that the boat is alongside a ship or landing place and manned by two boat keepers. The crew should be detailed for their thwarts before manning the boat ; in a whaler the bowman, No. 3 and stroke pull starboard oars and sit on the port side of their thwarts, the remainder pull port oars and sit on the starboard side of their thwarts. On the order " Man the boat ", the bowman and stroke relieve the boatkeepers of their boathooks and hold the boat alongside while standing, respectively, in the head and stern sheets, and the remainder sit on their appointed thwarts. When manning the boat the crew should be taught to step (not jump) onto the thwarts or benches and thence to the bottom boards ; they should also be taught to avoid stepping on the gunwale, to move carefully in the boat, and to step over the thwarts and not jump from thwart to thwart. The crutches should be unshipped, the fenders out, and the oars squared off in their proper positions.

Each oarsman should sit squarely and upright on his thwart, with the after edge of the thwart where his buttocks meet his thigh muscles. His stretcher should be adjusted so that when his feet are resting on it his knees are slightly bent ; his heels should be together and his toes turned outwards at an angle of 45°. In the position of " oars " his hands should be from twelve to eighteen inches apart, with the inner hand on the grip. The grip on the oar should be firm but light, with the fingers over the oar, the thumb underneath, and the inner wrist slightly arched. Both elbows should be close to the sides of the body and the back should be straight.

Initial Training

First Stage. At the order " Oars forward " each man bends forward from the hips, keeping his arms and back straight, until his trunk is between 30° and 40° from the vertical. In this position the oars should be at an angle of about 30° from the fore-and-aft line of the boat, with the blades about a couple of inches off the water and slightly over the vertical (see Fig. 170 (9), (10) and (1)).

At the order " Catch and pull through " each man lowers the blade of his oar into the water by raising his hands a few inches ; he then pulls the blade aft through the water by driving his feet against the stretcher and, while keeping his arms and back straight, swinging his trunk backwards until it is about 10° to 20° beyond the vertical (see Fig. 170 (2), (3) and (4)). The end of the stroke is made, with the trunk still in this position, by bending the elbows and pulling the loom of the oar in to the chest with the arm and shoulder muscles,

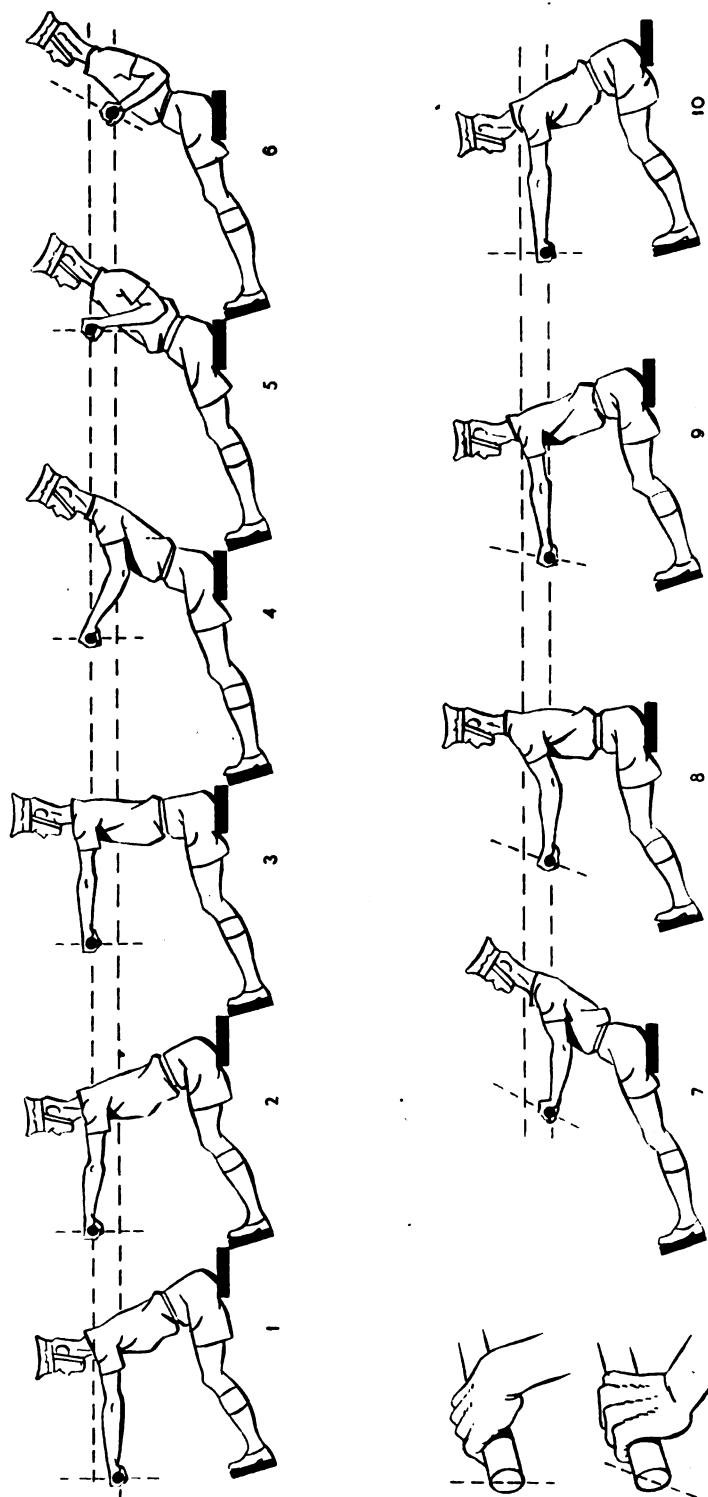


Fig. 170.—The stroke cycle

which should bring the blade of the oar just clear of the water at an angle of 45° with the vertical (see Fig. 170 (5)). These four stages are continuous.

At the order "Oars" the recovery is made by dropping the hands a few inches to bring the oar to the horizontal, and dropping the wrists to feather the oar so that its blade is horizontal. The arms are then thrust forward and the trunk is swung upright by the stomach muscles until the position of "oars" is again reached, this movement being helped by pulling with the legs against the straps which hold the feet to the stretcher (see Fig. 170 (6), (7) and (8)).

This sequence is continued until all the crew are proficient in handling their oars.

Attention should be paid at this and subsequent stages to the following points. The crew should reach well aft when in the "oars forward" position, but their buttocks should not leave the thwarts. The catch should be made exactly together with as much weight as possible on the looms of the oars, and the arms should be kept straight throughout the stroke until the trunk has reached its backward position; if this is done correctly the oars will come home easily at the end of the stroke. The trunk should swing backwards and forwards in the fore-and-aft line, and the elbows should be kept close to the sides at the end of each stroke. The back should always be kept straight; this ensures that the full weight of the body is applied to the loom of the oar and also allows the man to breathe correctly. The trunk should not be allowed to fall too far back at the end of the stroke, because this puts an undue strain on the stomach muscles and encourages the fault of pulling the trunk up to the oar. At the end of the stroke the hands must be dropped before the wrists to ensure that the blade is clear of the water before it is feathered. At the start of the recovery the hands should lead the body and not follow it.

Second Stage. The next stage of training is to blend the "oars forward", the "catch and pull through" and the "recovery", into an even rhythmic motion, without sacrificing the force of the catch, the drive of the pull through, and the speed of recovery.

At this and subsequent stages attention should be paid to the following points. In the "oars forward" position the shoulders should be kept braced back, and the arms and wrists should be rigid when the "catch" is made. At the moment of the "catch" and throughout the greater part of the stroke the legs should exert a powerful drive against the stretcher. The crew should begin and end each stroke together and any raggedness should be checked. There is no harm in allowing a crew to time the catch by glancing at the blades of the oars if in so doing the head is kept erect and facing aft. Any tendency to roll or turn the head should be checked because this will upset the balance of the body and the rhythm of the stroke. The crew should time the end of the stroke by the click of the oars shifting in the crutches. There should be no pause at the moment before the catch, and the catch should not be begun before the blade is in the water. If the blade enters the water with a splash it is a sign that the catch has been begun too early, which is a frequent cause of "catching a crab". The blade should leave the water cleanly at the end of the stroke, leaving a swirl in the water. If spray is thrown aft by the blade as it leaves the water the stroke has been finished too early and the hands have been dropped too soon. If a feathery sheet of water runs off the blade as it leaves the water the oar has been feathered too early by dropping the wrists before the hands; this also is a frequent cause of "catching a crab". If a

man "catches a crab" by feathering too early he should not attempt to force the blade out of the water, but should allow the oar to swing fore-and-aft before recovering it.

Third Stage. In the final stage of initial training the pause between strokes at the "oars" position is progressively reduced until each stroke is blended imperceptibly with the next. At this stage particular attention should be paid to the timing of the catch and the recovery, and to the rhythm of the stroke cycle. Tendencies towards over rigidity and overstrain should be checked and the easy application of force at the right moment encouraged. The three stages of training should not be hurried; each stage of the stroke cycle should be thoroughly mastered before it is blended with the others.

Hints to Instructors

General Hints

- (i) Patience in dealing with faults is essential.
- (ii) Insist on strict attention by all members of the crew.
- (iii) Where possible, faults should be demonstrated practically.
- (iv) The cause of a fault may be obscure; the instructor should be able to distinguish between cause and effect, and to trace a fault to its source.
- (v) The faults of each member of the crew should be corrected individually, and not by remarks addressed to the crew as a whole.
- (vi) Ensure that faults are not caused by defective or ill fitting equipment.

Faults to Guard Against

- (i) Using the biceps instead of the shoulder muscles to end a stroke; this results in the elbows sticking out from the sides.
- (ii) Faulty grasp of the looms; this is the cause of many faults.
- (iii) Over-reaching with the shoulders at the start of a stroke, instead of having them braced back.
- (iv) Meeting the oar and rowing deep at the finish; usually both are caused by ending the stroke with the arms alone.
- (v) Screwing to one side during the stroke, due to the oarsman using one arm or leg more than the other.
- (vi) Feathering under water, which is due to a faulty grasp, or to slurring into one the two motions of dropping the hands and turning the wrists at the end of the stroke.
- (vii) Uneven swing forward, due to a sluggish or early recovery, or to the misuse of the correct muscles in recovering.
- (viii) Faulty timing, which may be caused by rushing the forward swing, recovering too early or too late, under or over-reaching at the start of the stroke, or watching the blade of the oar at the recovery.
- (ix) Not rowing the stroke home; this may be due to a weak catch, a weak drive, an early recovery, or over-reaching at the start of the stroke.
- (x) Swinging across the boat when coming forward, due to not sitting squarely, or to leaning too much on the loom; the cause of leaning too much on the loom may be incorrect balance or positioning of the oar in the rowlock.
- (xi) Fouling the water while swinging forward; this may be caused by the stretcher being too close to the thwart, or by the hands not having been dropped far enough, or shot out from the chest quickly enough, on recovery.

- (xii) Bending the arms too soon, due to lack of drive with the leg and back muscles at the start of the stroke.
- (xiii) Clipping the water, due to faulty grasp of the loom at the start of the stroke, thus allowing the blade to enter the water at an incorrect angle.
- (xiv) Rowing deep ; due to slicing the blade into the water at the start of the stroke, the cause of which may be a faulty grasp or a late recovery.

HINTS TO COXSWAINS OF BOATS

It is an old Service saying that a ship is known by her boats ; when away in a boat remember therefore that you carry the credit of your ship with you.

Check the gear and equipment of your boat daily. This should be done when she is being scrubbed out, or before she is called away for the first trip of the day, or before she is lowered, or when you take over from your opposite number. Make good defects between trips ; report any which you cannot make good to the Officer of the Watch and the Boat Officer. After the last trip of the day make sure that the boat is ready in all respects for the first trip of the following day.

Smartness in the Boat

Ensure that your boat is manned smartly when called away. Always see that your crew are properly dressed in the correct rig and that they are wearing their chin stays. See that all gear is securely and neatly stowed.

In a pulling boat do not allow your crew to pull in a slovenly manner. Strict silence should always be maintained in a boat. The crew and passengers should not be allowed to stand up, except when necessary for carrying out their duties. Nobody should be allowed to place his arms or hands on the wash-strakes or gunwales, especially when the boat is alongside or about to go alongside.

Know your boat's pennants, and when away from your ship always keep a lookout for her recall or for any signals addressed to her. Memorise the salutes and marks of respect to be paid in boats, and other ceremonial drill in boats, all of which are given in the chapter on Ceremonial. Do not cross the bows of your superiors.

Casting off

When casting-off from an inner billet at the boom do not haul ahead, but drop your boat astern until she is clear of the outer boats ; this is of particular importance in a tideway. If your boat is in the outer billet, spring her ahead on the lizard. Do not drop astern to the gangway, but bring the boat under oars, sail, or power, from the boom to the accommodation ladder in the normal way. When getting under way ensure that all fenders are in and that no rope's ends or bights are hanging over the sides of the boat.

Unhooking

When unhooking a boat from her falls always unhook the after fall before the foremost fall. If the foremost fall is unhooked first the boat may swing out, and in a strong tideway may broach to. For the same reason, when hooking a boat to her falls the foremost fall should always be hooked on before the after fall.

Reporting for Orders

Report personally to the Officer of the Watch for your orders and make sure that you clearly understand them before leaving.

If you are sent to another ship with a message or letter deliver it personally to the Officer of the Watch or the quartermaster. If you have to wait, lay off well clear on her quarter, unless permission is granted to make fast to the boom, and keep a sharp lookout for the signal or hail to return alongside (see Fig. 171 for the code of gangway hand signals). Do not remain alongside an accommodation ladder unless expressly ordered to do so.

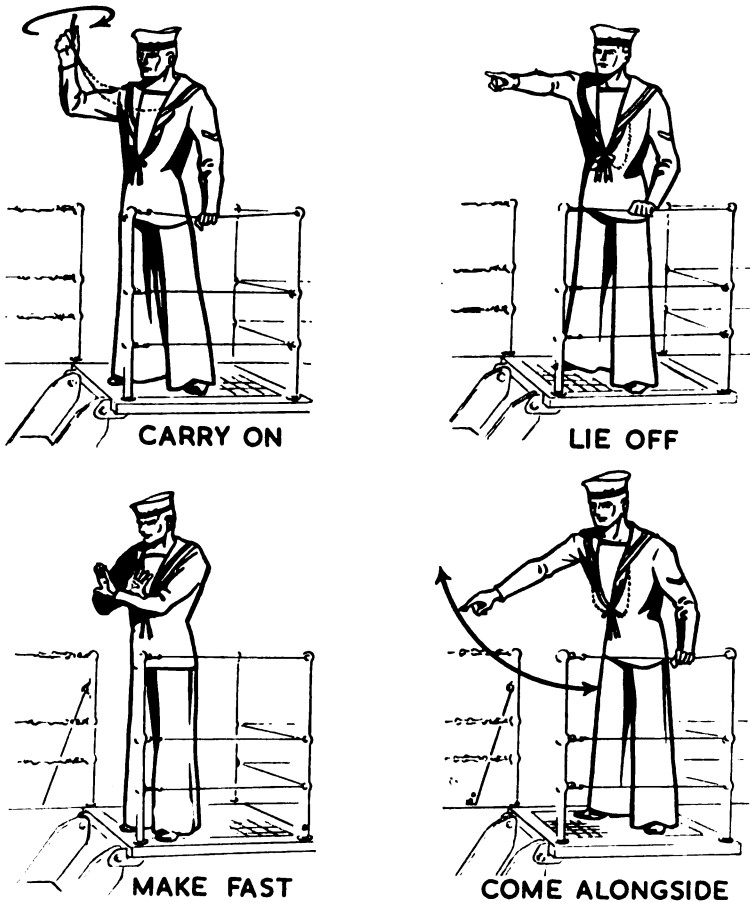


Fig. 171.—Code of gangway hand signals

When Under Way

In setting your course make due allowance for leeway or the set of any current or tidal stream. Remember when proceeding up stream in a pulling boat that the current is usually weakest inshore. If your course lies beam on to a heavy sea or swell it is better to steer a dog-leg course to windward than to steer the direct one. Keep a good lookout to windward in squally weather, and be prepared to make for shelter or the nearest ship should the need arise. Meet the wash of passing ships bows on, and, in a pulling boat, warn

your crew to mind their oars. Do not pass close under the bow or stern of a ship at anchor, and always give a wide berth to the bows of a ship anchored in a tideway. Be thoroughly conversant with the Rule of the Road.

Landing and Going Alongside

When going alongside a landing place, or a ship moored head and stern, always go alongside head to wind or tide, whichever is the stronger. When ordered to lie alongside a ship choose a position which is clear of scuppers or other discharge pipes. When going alongside a ship in a tideway avoid overshooting the accommodation ladder, because if you overshoot it your boat will very likely get jammed by the stream underneath the ladder. When alongside a ship in a tideway lead the gangway boatrope over the inner bow and secure it to the towing bollard, towing thwart, or bow cleat ; then steer your boat and you will find that she will answer her helm just as if she were underway at slow speed (see Fig. 200 on page 302).

When alongside a landing place do not allow the crew to leave the boat, and do not allow them to lounge about in the boat, smoke, or behave in any way likely to bring discredit on your ship or the Service. On your return to your ship report anything amiss in her appearance that you may have noticed while you were away.

Carrying Passengers and Stores

You should know the maximum number of persons, and the maximum weight, your boat is allowed to carry in calm weather ; remember that these are maximum limits for *calm* weather, and that you must reduce them according to the conditions and sea which your boat will encounter. (See the table giving the carrying capacities of Service boats on pages 348 and 352.)

When embarking stores they should be placed as far as possible amidships and low down in the boat. If the centre of gravity of the stores is above the thwarts or gunwale the boat will be top-heavy and tender ; if weights are placed right forward she will not rise to the waves and will be in danger of broaching to, and if placed right aft she will be in danger of being pooped by a following sea. When loaded, your boat should have an even trim fore and aft and no list to port or starboard, but when going before a heavy sea it is best to trim the boat slightly by the stern. If you are carrying top-weight alter course carefully, and if you are heavily loaded remember that the boat will carry her way for a much greater distance than when she is lightly loaded.

If you are sent to bring off unpackaged stores such as fresh meat or vegetables, see that you have a clean tarpaulin spread over the bottom of the boat to save both stores and boat from being fouled. When disembarking stores alongside a ship see that a net is slung from the ship's side to the gunwale of your boat to catch any stores which may fall between the ship's side and the boat.

Carrying money. If you are sent to bring off the Supply Officer with money take a small buoy and buoy-rope with you. Before the money is embarked the bag containing it should be secured to the end of the buoy-rope, which should be long enough easily to reach the bottom at any point on your passage back to the ship ; should any accident then occur the money can be recovered later by picking up the buoy and buoy-rope. When disembarking the money the buoy and buoy-rope should first be passed into the ship.

Anchoring

If you have to anchor see that the cable is correctly bent to the ring of the anchor and that the inboard end is secured to the boat. If of Admiralty pattern see that the anchor is correctly stocked with the forelock in place and moused. See that enough cable to reach the bottom is flaked ready for running, and stream it before the anchor is cast overboard. When the anchor is cast overboard have stern way on your boat to ensure that the cable is laid out along the bottom and that it will not foul the anchor. The length of cable by which you ride should be at least four times the depth of the water at high water, and, in a pulling boat, you should ride by your towing bollard by taking four turns of the cable around it and then seizing the inboard part to the outboard part. If the boat snatches at her cable in a heavy sea, pay out as much cable as possible. If she still snatches, and a 50 lb. sinker or stone of similar weight is available, it may be secured by a lizard to the cable and allowed to run down the cable to the bottom on the end of a messenger; this will act as a spring on the cable and so reduce the tendency of the boat to snatch.

When anchoring on a rocky bottom, bend the cable to the crown of the anchor and stop the bight to the ring, so that if the anchor jams under a rock when being weighed the stop will part and allow the anchor to be hauled clear and weighed by its crown.

If the boat is to be left unattended at anchor off a rocky shore or a steeply shelving beach, shackle a block to the ring of the anchor, reeve the boat's cable through it, and to the cable bend a messenger of the same size as the cable. Drop the anchor in a position which will allow sufficient scope of cable for the boat to ride to it and yet swing clear of the shore or rocks. After disembarking make fast a stern rope on shore allowing plenty of scope; then haul the boat seaward on the messenger until she has the correct scope of cable and make fast the messenger on shore.

Making Fast to a Boat Boom

When ordered to make fast to the lower boom secure to it in your proper berth; a pulling boat being lighter than a power boat is usually sent to the outer lizard. The painter should be rove through the eye of the lizard, then back through the thimble of the painter, and then be secured with a double sheet bend round both parts; the scope of the painter should be adjusted so that the boat rides easily without yawing or snatching in the prevailing wind, sea, and current or tidal stream; a fathom and a half is sufficient in calm weather. Secure the lazy painter to the Jacob's ladder and give it a greater scope than the painter.

Before ordering the boat's crew out of the boat see that:—

- all dirt inside or outside the boat is scrubbed or wiped off, particularly along the waterline;
- oars and boathooks are stowed on each side of the boat and secured by becketts to prevent them rolling about;
- all movable gear is securely stowed;
- in single-banked boats, the crutches are unshipped, stowed, and not left hanging by their lanyards;
- in double-banked boats the poppets are shipped;
- the tiller and rudder are unshipped;
- the ensign is furled and the ensign staff unshipped
- the awning is furled and stowed in its cover;

the fenders are out ;
the drop keel is housed.

When your boat is hoisted have her sides and bottom cleaned and washed down. Remove the plug, drain any bilge water into a bucket and clean out the bilges. Remove all gear which is allotted a special stowage in the ship, such as the boat's and carpenter's bags ; sails, masts, spars and rigging ; compass ; awning ; etc., and put on the boat's cover.

STOWAGE OF BOATS IN H.M. SHIPS

Crutches

A ship's boat is stowed in specially fitted crutches which support her bottom and bilges at two or more positions along her length. When a boat is stowed in her crutches they may entirely take her weight, or additional support may be afforded by keel chocks placed where most required, usually where her beam is greatest or below her engines. The bearing surface of each crutch is shaped to fit the shape of the boat's hull at the position where it is intended to bear, and each is padded and covered with leather so that the whole of the bearing surface is in contact with the boat. It is important therefore to ensure that a boat is "pitched" (*i.e.* lowered onto her crutches) so that the crutches bear in their correct positions (which are usually marked by copper strips tacked to the keel or bottom planking of the boat), and that the crutches fit correctly. If a boat is incorrectly pitched she will lose her shape, spring a leak, or be stove in. A shipwright should be in attendance whenever a heavy boat is pitched.

Boat's crutches can usually be removed to give more deck space if required. They are bolted to the deck, usually with vice-headed bolts, the holes for which are staggered so that the crutches cannot be replaced incorrectly. The crutches of boats not normally hoisted at davits are placed within the radius of the crane or derrick used for hoisting them, and such boats are known as "boom boats". Some crutches may be hinged to stow on the deck when not in use. A small boat may be stowed in removable crutches within a larger boat ; this is known as a "nested stowage".

If no crutches are available a boat may be stowed temporarily in an upright position (see Fig. 172) with her keel resting on wedge pieces, which should be placed at the positions where her crutches would take ; if these positions are not known the wedge pieces should be placed abreast the boat's bows and quarters, and amidships or below her engines, care being taken that the weight of the boat is evenly distributed between them. To keep the boat upright "high-lows" are placed on each side below her bilges ; larger boats should also be supported by two or three shores on each side, lashed in position under her rubbers.

A boat is secured in her crutches by securing pendants of chain or of wire rope. Their upper ends are fitted with clamps which fit over the gunwale, or washstrake, and their lower ends are fitted with lanyards, or a rigging screw, with which they are set up to eyebolts in the deck. In open boats a wire span is fitted between opposite clamps of the securing pendants and set up by a rigging screw or a lanyard. When a boat is crutched down her cover should be put on and secured by the lanyards to the shackles provided on the crutches. In hot climates it is particularly important that a boat should be covered during

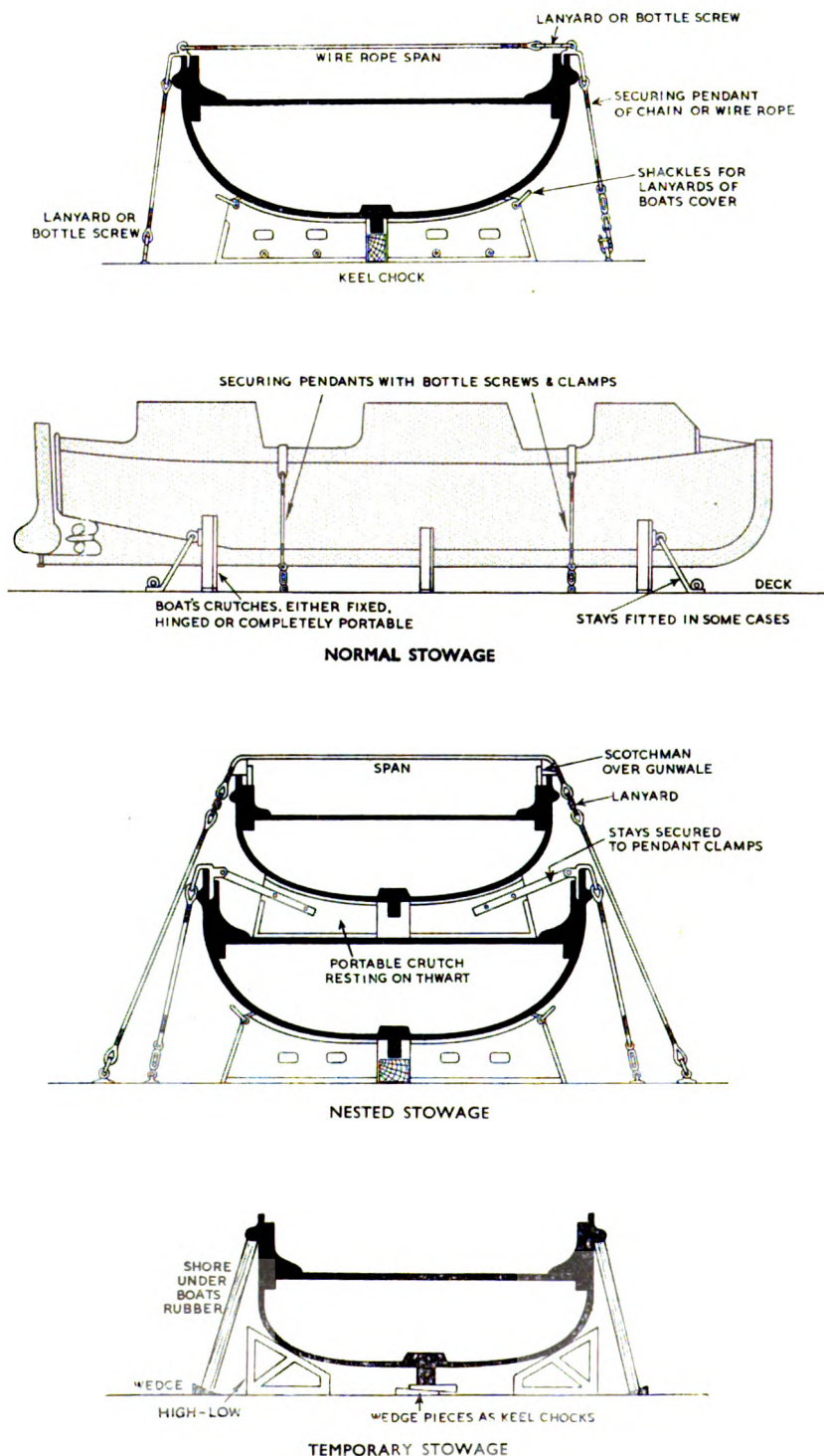


Fig. 172.—Stowage of boats in crutches

the day to preserve her structure from the heat of the sun, but in the evening the cover may be removed to allow her planks to take up the dew and so preserve her water-tightness.

Davits

The three main types of davit in general use are described below :—

(i) *The Radial Davit* (Fig. 173), which is pivoted at its heel so that it can rotate round its vertical axis. Each pair is stayed in position by fore and after guys, and a "span" set up between the davit heads; these must always be set up taut when the davits are turned outboard. A boat hoisted at these davits can be turned inboard by slipping the guys and turning first one davit and then the other inwards and inboard. After the boat is turned inboard it can be crutched down.

(ii) *The Quadrantal or Luffing Davit* (Fig. 174), which is hinged at its heel so that it can be canted outboard, or inboard to its stowage position. Each pair is stayed in the same manner as are the radial davits. When the davits are canted inboard the boat rests on keel chocks fitted on the davits, and no other stowage for the boat is provided.

(iii) *The Fixed Davit*, which is a fixed bar projecting horizontally from the ship's side, and each pair of which may be stayed in a similar manner to radial davits. They may be fitted with traversing gear; this consists of a traveller, fitted with an inhaul and an outhaul, which runs on rollers along the davit and by means of which the boat can be run inboard along the davits to its stowage and there crutched down.

DAVIT FITTINGS

The fittings of davits vary considerably according to the type of davit and the use to which it is put.

A Radial Davit (Fig. 173) has a locking pin at its heel by which it can be locked in either its outboard or its inboard position. It is also hinged at its heel so that it can be turned in and stowed flat on the deck when not in use. "Davit slings", consisting of a rigging slip and bottle screw, are fitted to each davit head, and the boat is slung on these when she is turned in or out or when her falls are renewed; if slung by her falls when being turned in or out she would foul them. A cleat for belaying the falls is fitted on the side of each davit, and a "standing life-line" of the same size as the falls is fitted to each davit head.

When a seaboat is hoisted at radial davits these are provided with the extra fittings described below and illustrated in Fig. 173. Each davit is fitted with a hinged bracket into which is clamped the "gripping spar". The boat is bowsed in to the spar by two "gripes" made of canvas-covered sword matting; these are rove from the head of each davit and then outside the boat to the heel of the opposite davit where they are set up on a rigging slip by jiggers or lanyards; a hammer for knocking off the slips of the gripes is secured by a lanyard to each davit. A "jackstay" with a lizard running on it is rigged from each davit head to an eye plate on the ship's side near the waterline; when the boat is hoisted or lowered these lizards are tended in the head and stern sheets to prevent the boat from swinging outwards if the ship is rolling. A staghorn bollard is fitted to the deck near the heel of each davit, to which the falls are

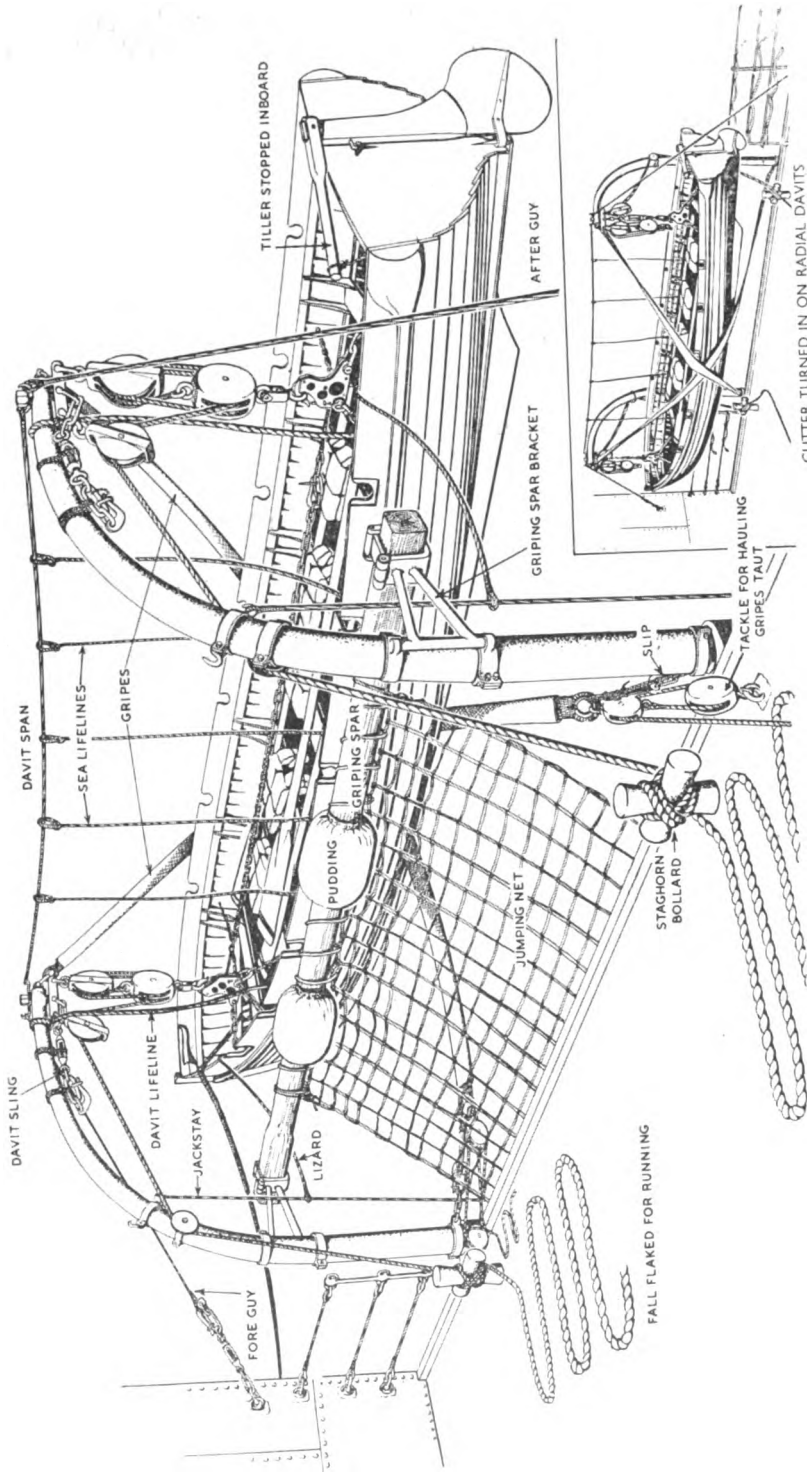


Fig. 173.—Cutter hoisted as a seabat on radial davits

belayed and from which the boat is lowered. Cordage "sea life-lines" (3-inch for cutters and 2-inch for whalers), one to each thwart except the bow and stroke thwarts, are slung from the davit span; they should be just long enough to reach the water when the ship is at light-load draught. If the freeboard of the ship is considerable the life-lines may be fitted at intervals of a few feet with standing Turk's heads to provide hand and foot holds for anyone having to man the boat or climb inboard after she has been lowered. A "jumping net" is rigged between the griping spar and the ship's deck to enable the crew to man the boat when she is hoisted at the davits.

Quadrantal Davits (Fig. 174) have fittings similar to those of radial davits, with the following exceptions. The davit is turned inboard and outboard by a worm engaged in a sleeved spindle and operated by a crank handle. When the davits are canted inboard the keel of the boat rests on chocks fitted on each davit; each chock is fitted with a locking clamp worked by a lever, and these clamps must be freed before the boat and the davits can be canted outboard. No griping spar is provided, but each davit is fitted with a "griping pad" against which the boat is bowsed by the gripes; the gripes must be slipped before the boat and the davits can be canted outboard. No davit slings are provided because the boat is stowed on the davits. The davits are not hinged at their heels for close stowage, nor are they provided with locking pins. Staghorns are not usually provided, the boat being lowered from cleats fitted on the davits. No jumping net is provided.

With this type of davit it is important to ensure that when the davits are canted outboard the guys and span are set up so that the heads of the davits are in line with their heels, and that they are correctly stayed in this position.

Fixed Davits may be fitted with guys and a span, and standing life lines. When used for a seaboat, jackstays and lizards, sea life-lines, a griping spar or griping pads, and jumping nets or Jacob's ladders may also be rigged. Davit slings are provided for slinging the boat when the falls are unrove or renewed, and crutches are provided for the boat in its stowage position. The upper block of each fall is secured to a traveller which runs on rollers along the horizontal davit. The traveller is hauled in and out by an inhaul and outhaul which are brought to a winch worked by hand cranks. The falls are of E.S.F.S.W.R. and their hauling parts are brought to power driven winches. As the boat is run out the winches must be veered, and as she is run in the slack of the falls must be taken down by the winches.

TURNING IN A BOAT ON RADIAL DAVITS

The boat is slung on the davit slings, the standing life-lines are passed inboard and manned, and the fore and after guys are slipped. The after davit is turned aft by hauling on its life-line, and the foremost davit is turned aft by bowsing down on the span. The foremost davit is then turned inboard and then forward by hauling on its life-line, and the bows of the boat are guided inboard and forward. The after davit is then turned inboard and the stern of the boat guided inboard, and the boat is then swung aft (see inset of Fig. 173). The boat is turned out in the reverse manner.

Before turning in a seaboat the gripes are slipped, the griping spar is unshipped and placed in the boat, and the spar brackets are housed. If the ship is rolling, frapping ropes to check the swing of the boat must be rove before the gripes are slipped. These are rove parbuckle fashion, from inboard and over and round the boat at her bows and quarters.

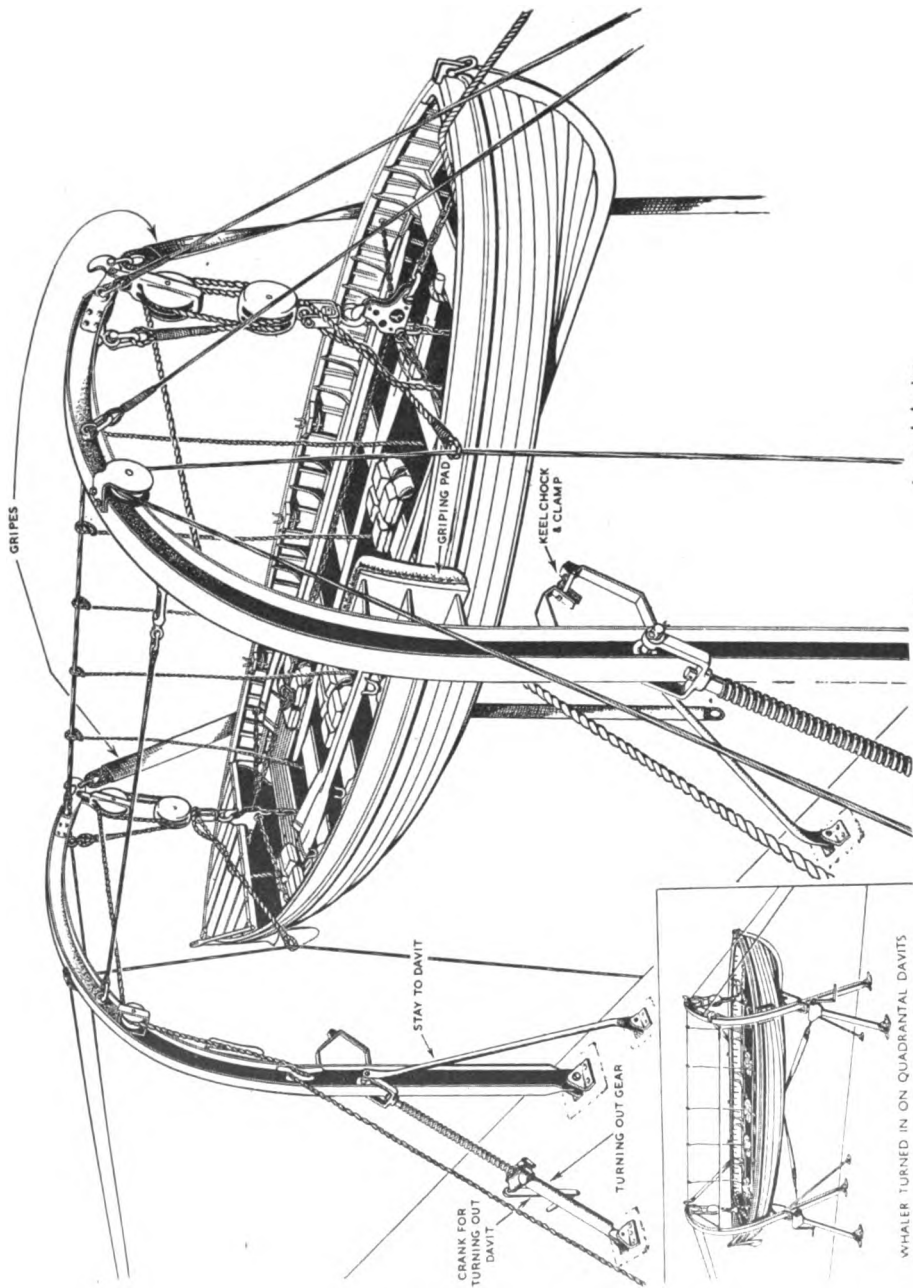


Fig. 174.—Whaler hoisted as a seaboard on quadrantal davits

WHALE TURNED IN ON QUADRANTAL DAVITS

REEVING, FITTING AND MAINTENANCE OF FALLS

Boats falls, and the way in which they are fitted and rove, vary considerably. The purchase may be three-fold, five-parted, two-fold or a luff. Some falls have two blocks, either fixed or swivelling, at each davit head to separate the hauling part from the running parts. The lower blocks are usually fitted with a swivel-ring shackle as a becket to allow the boat's slings to be hooked on to the falls without having to remove any turns in the falls; the pin of the swivel-ring shackle must always be moused with seizing wire. The standing part of the fall may be secured to the upper or the lower block, or to the davit head. The way in which the falls are rove is determined by the lead of the hauling part from the throat of the upper block to the leading block on deck. The size of a fall, which is determined by the weight of the boat and the type of purchase used, varies from 2-inch to 4½-inch manila for boats hoisted by hand. The falls of boats hoisted by power-driven winches are usually of 2-inch E.S.F.S.W.R. The length of a fall depends upon the number of parts in the purchase, the height from the davit head to the waterline, and the length of run along the deck for the hauling part. Seaboats' falls are marked with bunting so that when the boat is hoisted the falls may be married at their marks and the boat hoisted clear of the water on an even keel.

When the falls take the weight of the boat they may have a tendency to twist as the boat is lowered or hoisted, especially if they are new, and this may be checked by a bar passed between the parts and tended by the bowman or stroke oarsman. After a boat is lowered at sea the falls should be recovered inboard. They should be handed outboard as the boat returns to the ship; the inboard parts or the standing part of each fall should be kept in hand until the boat is hooked on to ensure that the fall is clear for running. After a boat is lowered in harbour the falls should be rounded up, the lower blocks shackled to the heels of the davits, and the hauling parts reeled up or flaked down.

A boat's falls should be carefully inspected at frequent intervals, at the least every three months, and they should be renewed or turned end for end if their condition warrants it. The life of a boat's falls is considerably less in tropical than in temperate climates, owing to heat, damp, and the effects of the sun's rays. Before deciding to turn a fall end for end it should be carefully inspected for any signs of deterioration or wear; this applies particularly to the last few fathoms of the hauling part as these will become the part most subject to wear when transposed. Any slack-jawed rope should be discarded. Before reeving a new boat's fall it should be well stretched to obviate the tendency of new rope to kink.

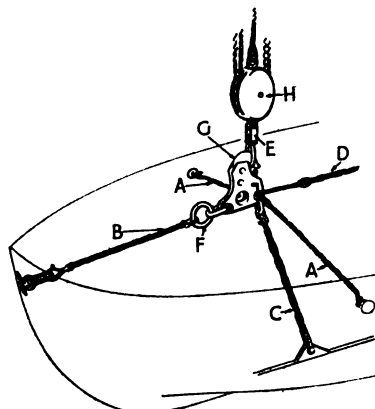
SLINGING, LOWERING AND HOISTING BOATS

Slings

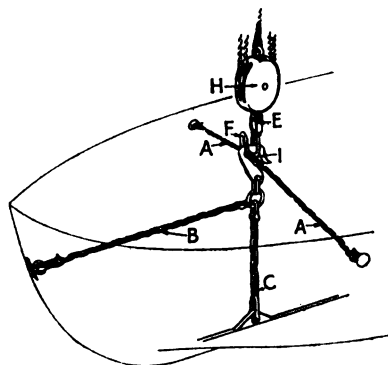
All round-bilge boats and some hard-chine boats are fitted with "hull slings." In addition, "purchase slings" are provided for boats which are hoisted by a crane or derrick.

There are two sets of hull slings, the forward sling and the after sling, each consisting of two legs of rigging chain or wire rope joined by a hook or a ring (see Fig. 175). The ends of the legs are shackled to sling-plates in the keel and hooked to ring-bolts in the stem and stern post. Two "steadying spans" of chain or wire rope are shackled to the hook or ring of each sling and hooked to eyebolts fitted to the gunwales of the boat; their purpose is to

keep the boat on an even keel as she is hoisted. If the boat is normally hoisted by a crane or derrick the legs of each sling are joined to a ring, to which is hooked a leg of the purchase sling.



AFTER HULL SLING OF A SEA BOAT



AFTER HULL SLING OF A BOAT OTHER THAN A SEA BOAT

Fig. 175.—Hull slings of boats hoisted on davits

KEY

- A STEADYING SPANS HOOKED TO EYEBOLTS IN GUNWHALES
- B AFTER LEG OF SLING HOOKED TO AFTER RINGBOLT
- C LOWER LEG OF SLING SHACKLED TO SLING KEEL-PLATE
- D WIRE PENDANT OF FORE AND AFTER
- E SWIVEL-RING SHACKLE ON LOWER BLOCK OF FALL
- F RING FOR DAVIT SLING
- G ROBINSON'S DISENGAGING HOOK
- H LOWER BLOCK OF FALL
- I ROBINSON'S COMMON HOOK

The purchase sling is a span, usually of wire rope, consisting of two legs connected by a ring to which is hooked the purchase of the crane or derrick. The ends of the legs are hooked to the rings of the hull slings (see Figs. 176 (i) and 177).

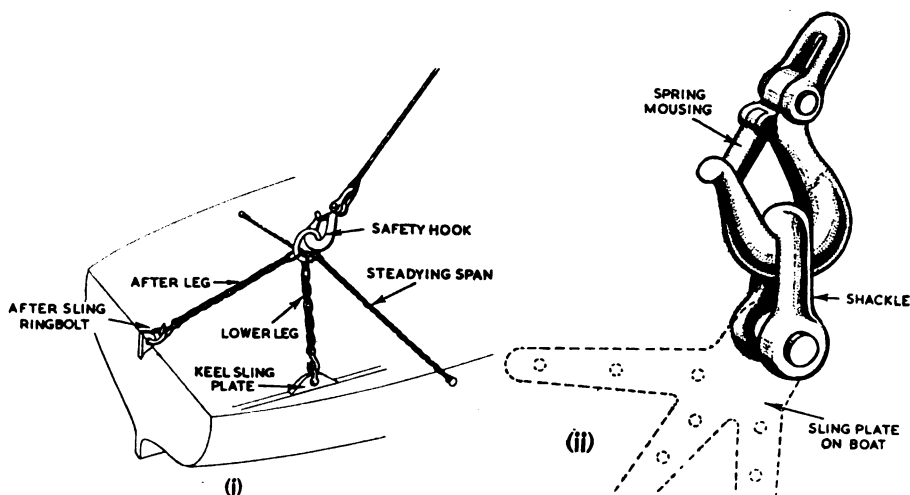


Fig. 176.—Hull slings of boom boats

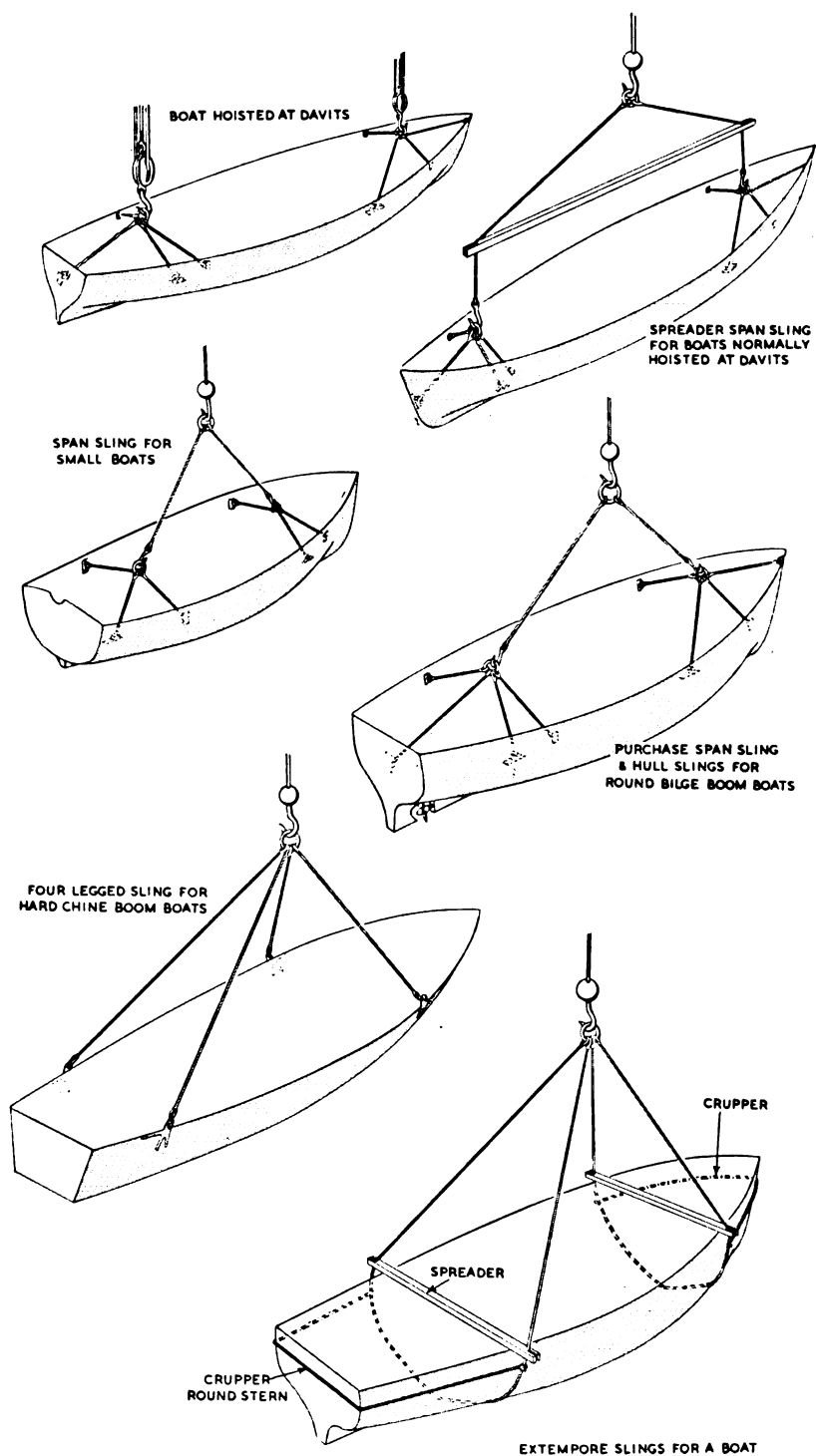


Fig. 177.—Methods of slinging boats

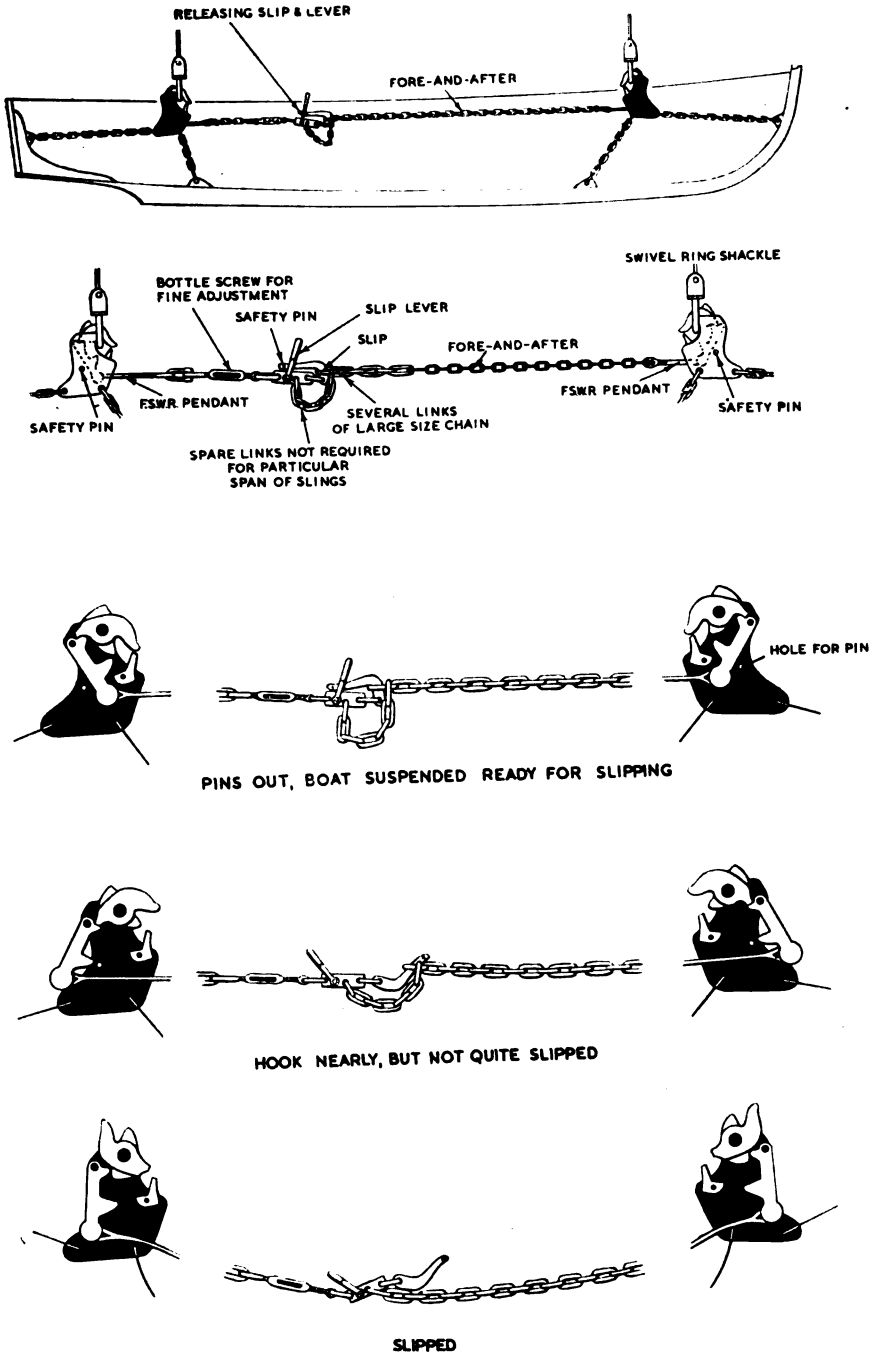


Fig. 178.—Action of Robinson's disengaging gear

Hard-chine boats usually have no hull slings, and the purchase sling, which has four legs connected to a central ring, is hooked directly to four sling-plates fitted to the gunwale of the boat at each bow and quarter (see Figs. 176 (ii) and 177). Care should be taken that each pair of legs is correctly hooked to its respective sling-plates, otherwise the boat will not be slung on an even keel; each leg should therefore be marked so that it can be distinguished from the others.

Boats which are normally hoisted at davits may be provided with a purchase sling, which consists of a two-legged span on a "spreader" (see Fig. 177). The purpose of the spreader is to equalise the stress in the legs of the boat's slings; without it almost all the weight of the boat would come on the ringbolts in the stem and stern posts and either cause them to draw or distort the boat. Spreaders are marked with the weights to which they have been tested, and it is important that a spreader of the correct length and strength be used.

Boats not provided with slings may be hoisted by extempore slings made up of a pair of gripes, or of manila or F.S.W. rope. If the boat is heavy, chafing pads should be provided at the gunwales, and wooden athwartship spreaders of 3 or 4-inch cross section may be necessary to prevent the slings from crushing the sides of the boat (see Fig. 177).

The slings of all boats are fitted in the dockyards by qualified shipwrights, care being taken to ensure that the weight of the boat will be correctly distributed between the legs of the slings as she is hoisted or lowered. The slings of boats which are hoisted at davits are carefully adjusted to conform to the span of the davits; a boat should therefore be hoisted by her own slings and at her own davits whenever practicable, and when lowered her slings should be carried in the boat and not sent inboard. A boat, except when she is a seaboat, should not be left supported on her slings alone for longer than is necessary, otherwise her hull may be strained or distorted.

When a boat is drawn from store an application should be made to the Manager of the Constructive Department of the yard (M.C.D.) for her slings to be fitted. A boat's slings are adjusted to suit the span of the davits at which she is hoisted and they are therefore part of the ship's and not the boat's equipment; they should not therefore be transferred with the boat when she is returned to store.

Disengaging Gear

When a boat is lowered at sea, both when the ship is stopped or making way, it is essential that both her falls should be disengaged simultaneously just before she reaches the water, thus allowing her complete freedom of manoeuvre immediately she is water-borne. This is effected by providing the boat with quick-release hooks which can be slipped simultaneously. There are several types of slipping devices in use, but that supplied to H.M. ships is called the "Robinson's disengaging gear", three sets of which are supplied to each ship, one for each seaboat and one spare.

The gear consists of two tumbler hooks, to which are connected the legs of the slings and the steadying spans (see Fig. 178). The mousing link of each hook is secured in place by a removable safety pin, and the releasing devices within the hooks are connected by a span called the "fore-and-after". The fore-and-after is made up of two wire rope pendants which are connected by a chain; a bottle-screw slip is shackled to the after pendant and its tongue

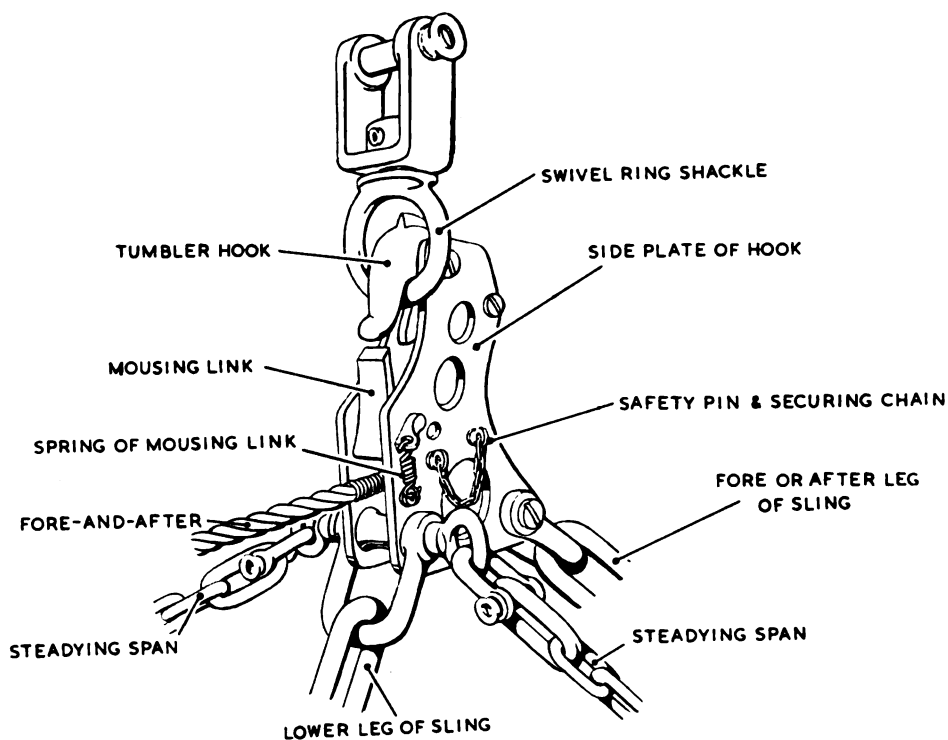


Fig. 179A.—Robinson's disengaging hook

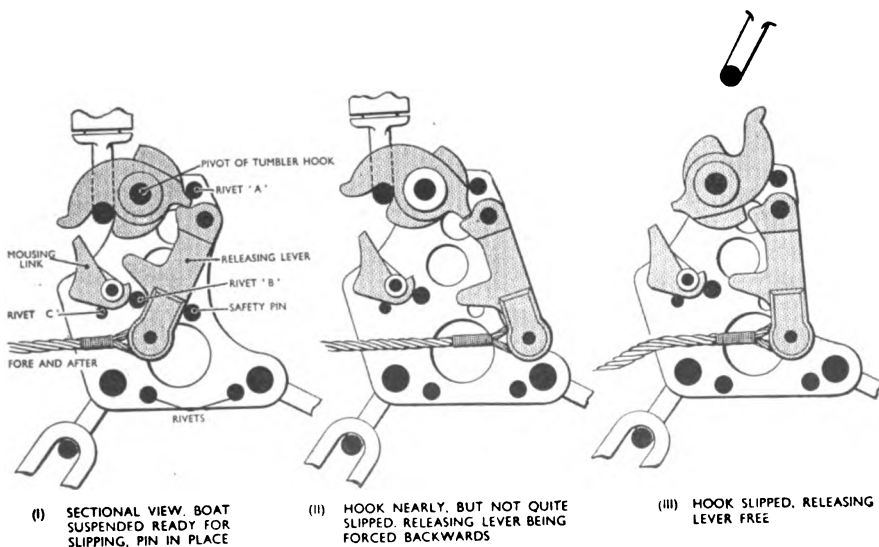


Fig. 179B.—Action of Robinson's disengaging hook

engages in one of the long links of the chain ; the slip is operated by a releasing lever.

When the boat is slung on the falls with the fore-and-after slack the weight of the boat is on the safety pins and they cannot be removed from their hooks ; but when the fore-and-after is set up taut the weight of the boat is taken off the pins, which can then be removed, so that when the slip of the fore-and-after is released by its lever the two hooks are released simultaneously from the lower blocks of the falls.

A disengaging hook is illustrated in Fig. 179A, and its operation is shown in Fig. 179B (i), (ii) and (iii). Fig. 179B (i) shows the parts of the hook when it is set up ready for slipping with the weight of the boat on the hook. The tumbler hook is pivoted between the two side plates, which are riveted together, and its tail is supported on the nose of the releasing lever which is pivoted through its head. In this position the pull of the weight on the hook forces its tail down onto the nose of the releasing lever and so forces the heel of the releasing lever back against the safety pin, which is thus jammed in position. The hook is prevented from closing by the rivet A which bears on its tail, and the forward travel of the toe of the releasing lever is limited by the rivet B. The jaws of the hook are moused by the mousing link, which is pivoted at its foot and held in place by a spring (see Fig. 179A). The turning outwards of the mousing link is limited by the rivet C, and its turning inward is limited by the toe of the releasing lever.

The end of the fore-and-after is connected to the tail of the releasing lever, and when the fore-and-after is bowsed down the tail of the releasing lever is drawn forward slightly, thus taking its weight off the safety pin, which can then be removed from its hole. The hook is then held in place by the releasing lever and the fore-and-after.

When the fore-and-after is slipped the releasing lever is free to turn on its pivot, so that it is turned backwards by the pressure of the tail of the tumbler hook on its nose (see Figs. 179B(ii) and (iii)). Eventually the tail of the hook slips off the nose of the releasing lever and the hook is up-ended, thus releasing the boat from the swivel-ring shackle on the fall.

To set up the hook for hooking on it should first be turned to its forward position, and then the releasing lever should be moved to its forward position by hauling on the pendant of the fore-and-after, after which the safety pin should be inserted in its hole and moused in place.

The length of the fore-and-after is to a limited extent adjustable by means of several links in the chain which are large enough to take over the tongue of the slip, so that the same fore-and-after can be used in several types of boat.

To set up the disengaging gear the hooks are first set up and then hooked on to the lower blocks of the falls, facing each other, and with the slip of the fore-and-after aft in the boat. The bottle-screw of the fore-and-after is then set to its maximum scope ; the fore-and-after is then set up hand taut by engaging the tongue of its slip in the most appropriate link of the chain, and is finally adjusted by screwing up the bottle-screw until the weight of the boat is not quite taken off the safety pins of the hooks, so that the safety pins can be easily removed when the fore-and-after is bowsed down by one man.

Drill for Lowering Boats from Davits in Harbour

Whenever a boat is being hoisted or lowered no one is allowed to stand before the foremost fall or abaft the after fall because if one fall parted, a man in either

of these positions would be crushed between the other fall and the bow or stern of the boat ; no one in the boat is allowed to place his hand on the falls, and everyone in the boat must hold on to the life-lines.

ORDER	ACTION
" <i>Away first whaler's</i> (or other boat's) <i>crew, lower your boat</i> "	The crew fall in abreast their boat and are mustered by the coxswain. The lowerers see that the falls are clear for running.
" <i>Turns for lowering</i> "	The bowman and stroke oarsman man the boat, see that the standing life-lines are clear for running and that the hooks are clear for slipping or unhooking, and the stroke oarsman puts in the plug. They stand close to their falls, holding on to the life-lines, and the stroke oarsman reports "Ready in the boat." The remainder of the crew divide themselves between the falls, take the falls in hand and remove the outer turns from the staghorns or cleats ready for lowering.
" <i>Start the falls</i> "	The falls are surged handsomely round the staghorns or cleats so that the boat is lowered slowly.
" <i>Lower away</i> "	This is the next order given if all is well. The falls are surged roundly so that the boat is lowered more rapidly, care being taken to keep the falls under perfect control and to keep the boat on an even keel.
" <i>Handsomely foremost</i> (or after) <i>fall</i> " or " <i>Avast lowering foremost</i> (or after) <i>fall</i> "	If the boat is not being lowered on an even keel these orders may be given to correct her trim. When she is again on an even keel the order "Lower away" is given, the boat being again lowered at the normal speed by both falls.
" <i>Light to</i> "	This order is given when the boat is waterborne. The lowerers let go the falls, remove the lowering turns from the cleats or staghorns and overhaul the falls sufficiently to enable the bowman and stroke oarsman to unhook the boat, <i>the after fall being unhooked before the foremost fall</i> . The falls are then recovered, the lower blocks are secured to the slips at the heels of the davits, the falls are rounded up and their hauling parts flemished or flaked down or reeled up. The boat is then pulled to the boom where it is manned by the remainder of the crew.

Drill for Hoisting a Boat at Davits in Harbour**ORDER**

" *Topmen* (or other part-of-ship) *reeve the first whaler's* (or other boat's) *falls.*" (The falls are usually rove by the part-of-ship to which the boat is assigned).

" *Away first whaler's* (or other boat's crew) *hook your boat on* " ;
or

" *Away boatkeepers of the first whaler* (or other boat), *hook your boat on* "

ACTION

The falls are cast off from the davits and overhauled until the lower blocks are a foot or two clear of the water with the parts clear for running. The hauling parts are rove through their leading blocks and led along the deck.

The boat may be manned by the full crew, or by the coxswain, bowman and stroke oarsman, or by the boatkeepers, and she is then pulled from the boom to a position under her davits. The bowman and stroke oarsman clear away the slings and hook on, *the foremost fall being hooked on first*, and each reports his fall hooked on to the coxswain, who then reports "*Boat hooked on, Sir.*" Meanwhile any other members of the crew climb inboard by the life-lines and man the falls.

While the boat is being hooked on, the watch, part of the watch, or other hands are piped to muster, *e.g.* "First part of port watch up first whaler." The hands man the falls evenly, with no one between the falls, and the Chief Boatswain's Mate, or the petty officer or leading hand in charge, reports "*Falls manned, Sir*". The following orders, which should be repeated on the boatswain's call, are then given :—

ORDER

" *Haul taut singly* "

" *Marry* "

" *Hoist away* "

" *Walk* "

" *High enough* "

" *Separate the falls* "

ACTION

The falls are hauled taut separately and all slack is taken down.

The falls are brought together and gripped as one by the two lines of men.

The hands run away with the falls and the boat is run up.

This order is given when the boat is nearing the davit heads. The hands break into a walk and walk the boat up the last foot or two to the davit heads.

This order is given as the boat reaches the davit heads. The hands cease hauling, but keep their weight on the falls.

The falls are separated from each other and each line of men keep their weight on their respective falls.

If the boat is not then horizontal at her davits the order "*Midship fall, hoist*", or "*Ship's side fall, hoist*" is given and the men on the fall indicated hoist away on their fall until the order "*High enough*" is given.

The order "Pass the life-lines" is then given and the bowman and stroke oarsman pass two or three turns with their lifelines under the hook of the sling and over the davit head, and then dog the end round all parts and back it up. On completion they report "All fast forward (or aft)" to the coxswain who then reports "All fast in the boat, Sir". The following orders are then given :—

ORDER

"Ease to the life-lines"

"Light to"

ACTION

The hands keep the falls in hand and walk back towards the davits until the life-lines take the weight of the boat and the falls slacken.

A bight of about two fathoms of each of the slack falls is hauled towards the davits and the remainder let go. The hands at the davits pass the bights over the davit fairleads, haul taut, belay them to the staghorns or davit cleats, and report "Foremost (or after) fall belayed, Sir".

The life-lines are then eased until the falls have the weight of the boat; the falls are then unrove and coiled down or reeled up, and the life-lines are unrove from the slings and their ends coiled in the bottom of the boat. The crew then square off their boat on an even keel, clean her and see that she is shipshape and her gear secured or stowed.

Drill for Lowering a Seaboat

Usually the seaboat on the lee side is ordered to be manned. In a rough sea oil may be used to lessen the breaking of the waves, and a stern fast may be secured to the lower block of the after fall; the stern fast and boat-rope are manned and tended to prevent the boat surging fore and aft as she is lowered.

ORDER

"Away seaboat's crew, man the port (or starboard) seaboat." (If the seaboat is required to rescue a man fallen overboard the order may be *"Away lifeboat's crew, man the port (or starboard) lifeboat"*).

"Slip the gripes"

"Turns for lowering"

"Start the falls"

ACTION

The crew man the boat, put on their life-jackets, get their oars ready, sit on their thwarts, grasp their life-lines, and stand by to fend off the boat. The bowman and stroke oarsman unmouse the safety pins of the hooks and then take the jackstay lizards in hand. The lowerers (two to each fall with a leading hand in charge) see that the falls are clear for running.

The lowerers knock the slips off the gripes and then, if the boat is hoisted at quadrantal davits, free the keel chock clamps and cant the davits outboard by their hand cranks. If there is time the gripes are passed inboard over the davit heads, if not they are left hanging outside the boat.

As in harbour.

As in harbour.

ORDER	ACTION
" <i>Lower away</i> "	As in harbour, but if the ship is rolling, the bowman and stroke oarsman keep the boat from swinging outward by tending the lizards, if necessary taking a turn with them round their thwarts, and the midship oarsmen fend the boat off from the ship's side with the looms of their oars. This order is given when the boat is a foot or two clear of the water, or just clear of the wave crests. The lowerers stop lowering by holding on to the falls. The midship oarsmen bear down on the fore-and-after to take the weight off the safety pins of the disengaging hooks, and the bowman and stroke oarsman then remove the safety pins and hold up their hands. The coxswain grasps the slip lever of the fore-and-after, removes its locking pin and reports " Pins out, Sir ", at the same time holding up his disengaged hand.
" <i>Avast lowering</i> "	The coxswain slips the fore-and-after, grasps the tiller and parts its stop, and then orders " Give way ". Immediately the boat is in the water the crew bear off hard from the ship's side, ship their oars and give way. If the boat-rope has been secured in the boat the bowman slips it by order of the coxswain. (If there is no way on the ship the boat may have difficulty in sheering off ; to help her in getting clear the boat-rope should be manned and the boat be hauled forward a short distance to give her sufficient headway to sheer off).
" <i>Out pins</i> "	The falls and gripes are then hauled inboard ; the falls are then rove for hoisting the boat on her return to the ship, and a stern fast is provided. In calm weather the boat-rope is stopped, at about a fathom from its eye, to the lower block of the foremost fall, but in rough weather it is stopped to the upper guard rail abreast or abaft the after davit, ready for passing into the boat as soon as she is within reach. The lizards should be recovered (by means of a light line previously stopped to their eyes) and their ends be stopped to the lower blocks of the falls.
" <i>Slip.</i> " (If the sea is rough the order to slip is timed so that the boat will drop on the crest, and not in the trough, of an approaching wave.)	

Hoisting a Seaboat

A lee is formed by the ship if possible. The falls are manned and lowered over the side, care being taken to allow the right amount of scope and to tend the inboard parts to prevent them from twisting and the lower blocks from thorough-footing themselves. Immediately the returning boat gets within reach, if in rough weather, the boat-rope is passed to her and made fast between the two foremost thwarts in the same manner as for lowering, and the end of the stern fast is passed into the sternsheets, where it is secured; in calm weather the boat-rope is passed on the foremost fall. As the boat rises to a wave the foremost fall is hooked on, and immediately afterwards the after fall is hooked on, the coxswain then at once reporting "Hooked on, Sir".

Just before the boat is hooked on the order "Marry to your marks" is given to the hands on the falls, and they are married with their strips of bunting in line with each other but allowing sufficient slack in the falls for hooking on.

The moment the boat is hooked on the order "Hoist Away" is given and the boat is run up clear of the waves as quickly as possible. The boat-rope and stern fast are manned inboard and tended to prevent the boat surging forward and aft as she is hoisted. The bowman and stroke oarsman tend their lizards and the midship oarsmen stand by to fend the boat off the ship's side. If the boat is surging heavily it may be necessary to give the order "Avast hoisting" while the surging is checked. The boat is then hoisted as when in harbour, the gripes are rove and set up, and the boat is secured for sea. If the boat is hoisted at quadrantal davits the davits are canted inboard before the gripes are rove, and the keel chocks are then clamped in position.

The crew then replace all gear ready for lowering, after which the coxswain reports to the Officer of the Watch that his boat is secured for sea.

Hoisting a Swamped Boat

Before hoisting a swamped boat it should first be made fast under the davits or crane by a head-rope and stern fast. The falls or purchase sling should then be hooked on to the boat's slings, and all slack be taken down; if the boat is not fitted with slings, extempore slings must be passed under her bows and quarters and be kept from crushing the gunwale by athwartship spreaders. The boat should then be baled out while the falls are kept taut; no attempt should be made to hoist her until most of the water is baled out, but when nearly empty she may be hoisted a few inches by the foremost fall to spill the water over her stern and so assist the balers. When almost empty of water the boat may be hoisted clear of the water and allowed to drain, and then be hoisted in the usual manner.

Hoisting Boom Boats In and Out

Hoisting Out. A boom boat must be hoisted out of her crutches with as much care as she is pitched in them, otherwise she may easily be damaged. The purchase of the crane or derrick should exactly plumb the ring of the sling when the weight of the boat is evenly distributed between its legs. For a light boat in calm weather only two steadying lines are necessary, one made fast to her bows and the other to her stern, but a heavy boat should have a steadying line made fast to each bow and quarter. *No men should ever be in a boat when*

she is slung inboard ; when hoisting her out, the crew should man her when she is slung over the side, and when hoisting her in they should step out of the boat on to the deck as she reaches deck level.

In rough weather special precautions are necessary if there is any appreciable movement on the ship. The ship's side and the boat should be well fendered. Long $2\frac{1}{2}$ -inch luffs should be used for the steadying lines, and they should be secured to the boat's bow and quarter cleats with wire rope stops. Two head ropes should be rove, one as a boat rope through a clump block on the lower boom, and the other from well forward in the ship outboard of all and secured in the bows of the boat ; and two grass-line stern fasts should be led from well aft and secured in the stern sheets. The head ropes and stern fasts should be tended to prevent the boat surging as she is lowered. If the ship is rolling heavily it may be found advantageous to work the topping lift of the derrick or crane so as to lower the boat against the ship's side. When the boat is in the water she is hauled clear of the side to the lower boom on the boat-rope.

Hoisting In. As soon as the boat comes alongside under the purchase of the crane or derrick, head and stern lines should be passed into her and made fast ; they should be led from well before and well abaft the boat, and tended. When the boat is level with the deck two more steadying lines may be made fast to her bows and stern if necessary.

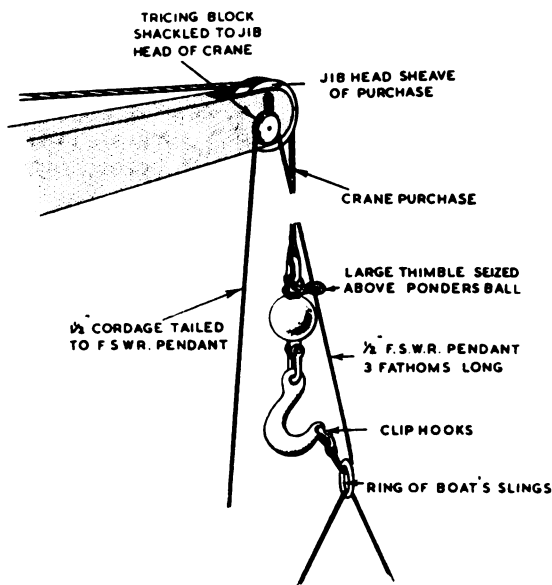


Fig. 180.—Tricing-line rove for hooking boat's sling to hook of crane purchase

In rough weather a boat's crew may have difficulty in hooking the sling of their boat on to the purchase hook of the crane or derrick ; this is made easier if a tricing line is rove at the head of the crane or derrick as shown in Fig. 180 ;

the end of the line is passed into the boat, rove down through the ring of the sling, and hooked to the link on the bill of the purchase hook, so that the ring of the sling is triced onto the purchase hook as the hook is lowered.

In particularly rough weather the ship's side should be well fendered, oil should be poured on the water forward to prevent the seas from breaking, and the boat should be dropped astern on her boat-rope from the lower boom to the derrick or crane. Another head rope should be led from well forward in the ship and secured in the bows of the boat, and an extra stern fast should be passed. As the boat is hoisted clear of the water the head rope and stern fasts are tended and the boat-rope cast off, and when she is level with the deck the steadying luffs are made fast, the crew leave the boat, and she is hoisted inboard.

SEABOATS

One or two of the boats slung on davits are kept ready for lowering at a moment's notice when at sea, one on each side of the ship if she is provided with two seaboats. A seaboat is used for rescuing any man who may fall overboard, communicating with another ship or the shore, recovering practice torpedoes, or for any other occasion when a boat is required at short notice at sea.

In order that she may be available at immediate notice a seaboat is kept turned out at her davits, unless hoisted at quadrantal davits. All the necessary gear must be in the boat, and she must be fully secured at her davits against the rolling or pitching of the ship.

The coxswain of a boat detailed for seaboat is responsible for securing and equipping her as a seaboat before the ship puts to sea, and the coxswain of the seaboat's crew of the watch is responsible that the boat is kept correctly secured, equipped, and ready for immediate use until the ship returns to harbour. A full crew and the necessary number of lowerers are detailed from each sea watch, and throughout their duty watch they stand by in the vicinity of the boat to man her immediately the order is given by the Officer of the Watch. The crew and lowerers are mustered by the coxswain when leaving or entering harbour and at the beginning of each watch, and the boat is inspected by the coxswain at the same time. If all is correct the coxswain then reports to the Officer of the Watch: "Seaboat's crew and lowerers of the watch correct, Sir; disengaging gear correctly set up; falls clear for running; boat (or both boats) clear of water and plugs in".

The seaboat's crew and lowerers are usually ordered to "man the port (or starboard) seaboat for exercise" once in each night watch. Only one crew, with lowerers, are detailed whether there are one or two seaboats prepared.

The coxswain should inspect his boat (or boats) during his watch if there is a likelihood of anything being amiss. If the boat requires draining he must first ask the Officer of the Watch's permission to remove the plug, and he must report to him when it is replaced.

Securing a Seaboat for Sea (see Fig. 173)

When securing a seaboat for sea the following details should be attended to.

The boat should be hoisted close up to the davit heads, and the falls should be belayed to the staghorns, if fitted, otherwise to the davit cleats. The hauling parts of the falls should then be reeled up.

The disengaging gear, which should have previously been overhauled and oiled, should be set up and tested for tautness.

The griping spar (if fitted) should be clamped securely in its brackets and a jumping net or Jacob's ladder be rove between it and the deck edge. The gripes should be shackled to the davit heads and well set up round the boat so that she is firmly bowsed in to her griping spar or her griping pads. The hammers for slipping the slips of the gripes should be secured to the heels of the davits by lanyards.

The guys and span should be correctly set up, and the davits be locked in position if fitted with locking pins. The lizards should be rove on the jackstays, and the jackstays should be secured to the davit heads and to the eyebolts in the ship's side ; (unless in harbour and a boat is available the jackstays will have to be secured at the waterline by lowering a hand over the side in a boat-swain's chair). The lizards should be lightly stopped in the head and stern sheets of the boat ; *on no account should they be hitched to the lower block of the falls, because if there is any sideways stress on the lower blocks when the boat is slipped the hooks may not disengage correctly.* Jackstays are not usually fitted in ships with a low freeboard.

The sea life-lines should be rigged on the davit span and lightly stopped in position, and with the standing life-lines should be coiled down on the thwarts clear of where the oarsman sit and clear for running. A life-jacket for each member of the crew and one spare should be laid on the thwarts and stern benches. The rudder and tiller should be shipped, and the tiller stopped over towards the ship's side by a split yarn ; the rudder and tiller are then in their correct position to steer the boat out from the ship's side when the boat is slipped. A strong pull on the tiller should carry away the stop.

Crutches should be shipped (or the poppets unshipped) and their lanyards should be secured in the boat. The oars and boathooks should be lightly stopped to prevent them rolling about, and the stretchers should be correctly fitted in place. Bottom boards and gratings should be secured, except those in the wake of the slings which should be removed from the boat and stowed inboard. The boat should be drained of any bilge water and the plug securely replaced.

A boat-rope of the same size or slightly larger than the boat's anchor cable, with a long eye spliced in one end, should be rove from a position in the ship well forward and be secured in the boat in the following manner : the eye is led over the inner bow, under the foremost thwart and up abaft it, and is secured by passing the towing bollard or a similar billet of wood through it and then laying the bollard (or billet of wood) across the two foremost thwarts (see Fig. 181). A lanyard long enough to reach from the deck to the waterline may be spliced into the boat rope a few fathoms from its eye so that it can be recovered after it has been slipped from the boat. The uses of the boat-rope are :—

- (i) to keep the boat heading in the same direction as the ship and thus prevent her from broaching to if the after fall fails to release when the boat is slipped ;
- (ii) to haul the boat ahead if she is slipped with the ship stopped, thus giving her sufficient steerage way to sheer out from the ship's side ;
- (iii) to tow the boat alongside the ship ;
- (iv) to haul the boat forward under the bows when the ship is coming to a buoy or going alongside ;

- (v) to haul the boat forward under her davits when she is approaching to hook on in a seaway ;
- (vi) to hold the boat under her davits while she is being hooked on ;
- (vii) with the help of a stern fast bent to the lower block of the after fall, to prevent the boat from surging as she is being hoisted or lowered in a seaway.

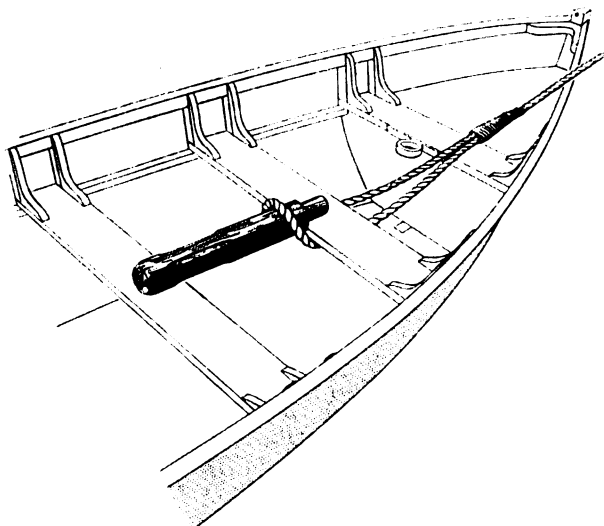


Fig. 181. Method of securing eye of boat-rope in bows of seaboat

The following gear should be stowed in the boat, clear of the slings and the feet of the crew : anchor and cable, boat's bag, carpenter's bag, compass, lantern and candles, bailer and/or bucket, distress signal box, barricoes full of fresh water, and tins of emergency rations.

The boat's sailing gear (if she is a pulling and sailing boat) should not be placed in the boat, but should be ready at hand to be put in if required.

Hints to Coxswains of Seaboats

You must get clear of the ship the moment your boat is slipped, so while the boat is being lowered warn your crew to stand by to bear off hard from the ship's side immediately she is slipped. If the boat-rope is made fast in the boat ensure beforehand that it can be slipped easily, and give the order to slip it before the boat sheers too far out from the ship's side. Your bowman must be alert and know his duties.

If you are to be towed alongside trim the boat a little by the stern so as to raise her bows, but station a man in the head sheets with his knife ready to cut or slip the boat-rope in emergency. Keep from 10 to 15 feet away from the ship's side. The length of the boat-rope should be adjusted inboard so that your boat rides with her forefoot on the crest of a wave of the ship's wash.

When away from your ship keep an eye on her for signals ; on your outward passage the stroke oarsman will be facing the ship, so tell him to watch for flag, lamp or other signals. If you are to pick up a man or some other inconspicuous object, the ship will probably direct you to the position. The moment you sight the object keep your eye fixed on it until it is alongside.

When going alongside a man or other floating object have a hand standing by at each end of the boat with a line ready to throw to him or to pass around the object, and manoeuvre your boat with the oars, do not boat them. Remember that your boat will drift to leeward faster than any object such as a man or a torpedo which is only just floating, so keep to leeward of it ; (see notes on torpedo recovery on page 329). If the object is to be hauled aboard, pass a line round it first, if possible, and then haul it in over the quarter into the stern sheets, meanwhile keeping your boat head to sea and on as even a keel as possible.

During your return to the ship have your slings and disengaging gear prepared for hooking on and ensure that the safety pins of the hooks are in place and moused. Your crew should be trained to prepare the gear with their eyes shut. When the hooks have been set up see they are tested by holding the slings up by the hooks.

When going alongside to hook on it is better to overshoot than undershoot the falls. If you overshoot, the boat-rope can be recovered and secured, and the wind and sea will soon drop the boat astern under the falls ; but if you undershoot, it will be difficult to haul the boat ahead even if the bowman has managed to grasp the after fall, and time will be wasted while a line is passed and the boat hauled ahead on it. If a line is thrown to you from the ship do not let your crew try to haul the boat up by it, but take a turn with it round a thwart and let the men in the ship do the hauling ; they are better placed to do so.

When hooking on ensure that the foremost fall is hooked on first. The lower blocks are fitted with swivel-ring shackles, so there is no need to take any turns out of the falls before hooking on. After hooking on, the blocks should be held up while the slack of the falls is taken down, and the bowman and stroke oarsman should take any turns out of the falls by turning round the lower blocks ; when the boat is being hoisted they should keep any turns from forming in the falls by means of a bar passed between the parts.

Teach your men how to handle falls and never allow them to grasp the running parts ; if the standing part is on the lower block, it, and it only, should be grasped. As the boat is being hoisted the midship oars should take their weight on the life-lines to lighten the boat.

SERVICE SAILING BOATS

Sailing Rig of 27-ft. Whaler (Fig. 182)

The mainmast is stepped in the keelson, held by an iron clamp to the second thwart, and stayed by two shrouds set up with lanyards to eyeplates in the gunwales and by a forestay of wire rope secured to a long shackle on the stem. The mizzenmast passes through a specially fitted crosspiece and is stepped in the hog abaft the stern benches ; it is not stayed. The boom of the mizzen can be triced up by a topping lift, and its heel is hinged to the mizzenmast.

The sails comprise a foresail, a standing-lug mainsail, and a triangular mizzen the foot of which is laced to a boom ; a trysail is also provided for use as a stormsail in place of the mainsail, or as a spinnaker, for which latter purpose a spreader is provided for bearing out its foot.

The foresail can be single-reefed and the mainsail double-reefed. The fore and main halyards are single whips rove through sheaves at the head of the

mast and set up to belaying pins under the second and third thwarts ; the fore halyard is of cordage and the main halyard is a wire rope pendant tailed with cordage. The main yard is hooked to a traveller shackled to the main halyard, and the tack of the mainsail is bowsed down by a tack-tackle rove to the keelson. The luff of the foresail is clipped to the forestay by spring hanks. The mizzen is laced to its mast and boom. The foresheets consist of two single parts of rope spliced to clip-hooks which hook into the clew ; the main

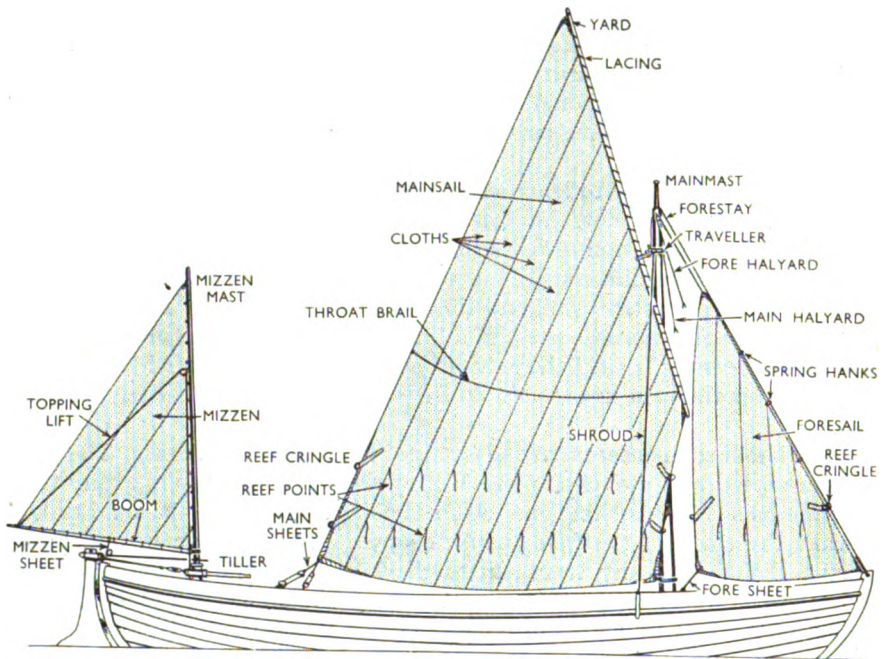


Fig. 182. Sailing rig of a 27-ft. whaler

sheets consist of two double whips rove through bullseyes and joined by a pair of clip-hooks to the clew, and the mizzensheet is rove from the boom through a block or a deadeye on the stern post to a cleat on the mizzenmast. Lizard bullseyes made fast to the risings are provided as fairleads for the foresheets, and eyeplates are provided in the stern sheets for the standing blocks of the mainsheets. The mainsail is fitted with brails and provided with a spreader for bearing out its foot when the boat is reaching or running.

Sail Drill for 27-ft. Whaler

If the boat is at the boom she should be made fast to an outer lizard so that the mast and yard clear the boom guy. The sailing gear should be placed as follows : mainmast amidships, heel forward ; main yard and mainsail in their cover alongside the mainmast, peak aft ; mizzenmast and mizzen in their cover, heel aft, on the stern benches ; boat's sailing bag, containing foresail, foresheets and lizards, mainsheets, main tack-tackle, stormsail, lacing, cod-line, twine and shackles, in the sternsheets ; all crutches unshipped and the oars stowed each side in their becketts.

Nos. 2, 3, 4 and stroke launch the mast aft until the heel is clear of the second thwart. Nos. 3, 4 and stroke lift the mast upright while No. 2 guides the heel into the mast step and clamps it in place. Bow and No. 2 clear away the forestay and shrouds and set them up taut, taking care to divide the strain equally between the shrouds. No. 3 clears away the running rigging and ensures that the traveller and fore halyard clip-hooks are hooked to the becket on the mast.

The coxswain and stroke secure the rudder lanyard inboard and ship the rudder, yokes, yoke lines and tiller. After seeing that the slings and other gear are clear of the wake of the mizzenmast, they stand the mast vertically on the cross bench and step it through its cross piece. They then clear away the mizzen and lower the boom, clip and mouse the mizzensheet deadeye to the stern post, and see that the mizzensheet is led between the yoke-lines. The mizzen may then be sheeted aft to steady the boat, or it may be topped up.

Bow hooks the tack of the foresail to the tack hook on the stem post, hanks the luff to the forestay, clips the fore halyard and sheets to the head and clew respectively, and mouses the hooks. No. 2 hoists and lowers the foresail to see that all is clear, and No. 3 reeves the foresheets through their lizards and secures the latter to the risings each side of his thwart.

Nos. 3 and 4 remove the mainsail and yard from their cover, clear away the mainsail, launch the yard forward and hook it to the traveller, ensuring that the fore and main halyards are clear of the hoist. No. 2 shackles the tack-tackle to the eyebolt in the keelson at the foot of the mast, and hooks the other end to the tack of the mainsail. Stroke hooks the running blocks of the mainsheets to the clew of the mainsail and their standing blocks to the eyebolts each side of the sternsheets, and mouses the clip hooks. No. 3 reeves the brails from the leach through the deadeyes at the throat of the mainsail, Nos. 3 and 4 then hoist the sail, No. 4 belays the halyard, No. 2 bowses down the tack-tackle and No. 3 brails up.

It is a good plan, particularly with an inexperienced crew, to lead the fore halyard under the mast thwart to starboard of the mast and belay it to a belaying pin under the third thwart, and to lead the main halyard under the mast thwart to port of the mast and belay it to a belaying pin under the fourth thwart; the halyards are then under the eye of the coxswain and clear of the gear around the mast. To belay the halyard it should first be passed over the after edge of the thwart and half round the belaying pin underneath, and then be fully set up by swigging off on the bight and taking down the resultant slack; the halyard should then be passed over the thwart, half round the belaying pin from forward and then over the thwart, and then be secured by jamming the bight between the top of the thwart and the original hauling part. If thus belayed there will be no complete turn round the thwart and the halyard will run free when cast off.

If the spinnaker is to be used, No. 2 sees that its halyard is rove clear of the other mast rigging and the hook clipped to the becket on the mast, and No. 3 clears away the spinnaker ready for hooking to its halyard and then hooks its sheet to the clew and places the spreader ready at hand.

Duties when under way. Bow always keeps a lookout ahead and to leeward, and tends the forestay and the foresail and its tack. No. 2 tends the fore halyard and the brails, sees that the running rigging round the mast is clear for running, and that the tack-tackle, shrouds, and forestay are correctly set

up. No. 3 tends the foresheets, spinnaker halyard and spreader, and assists No. 2 as necessary. No. 4 tends the main halyard, drop keel and spinnaker sheets, and assists stroke and No. 3 as necessary. Stroke tends the mainsheets and assists the coxswain with the mizzen as necessary. The coxswain tends the mizzensheet and topping lift.

To furl and stow the sails, mast and gear. No. 2 lowers the foresail, which is gathered in by bow, who unhooks the tack and foresheets, unhanks the sail from the forestay, and, if dry, folds it up. No. 3 unreeves and makes up the foresheets. If the spinnaker has been used and is dry it is folded by Nos. 3 and 4 and lashed with its sheet and halyard. No. 4 lowers the main halyard while No. 3 gathers in the mainsail and No. 2 unhooks the tack-tackle and the yard from the traveller. Nos. 3, 4 and stroke then fleet the yard aft, and, if dry, fold and roll the sail to the yard, lashing it with the brails. Stroke unhooks the mainsheets and makes them up. No. 2 hooks the fore halyard and traveller to the becket on the mast and unreeves the shrouds. Bow unreeves the forestay and hands it to No. 2, who then secures the stay and shrouds to the mast by crossing them alternately and lashing the ends to the mast with the lanyards. The coxswain and stroke unshackle and unreeve the mizzen-sheet, top up the mizzen boom, and, if dry, fold the mizzen round its mast and

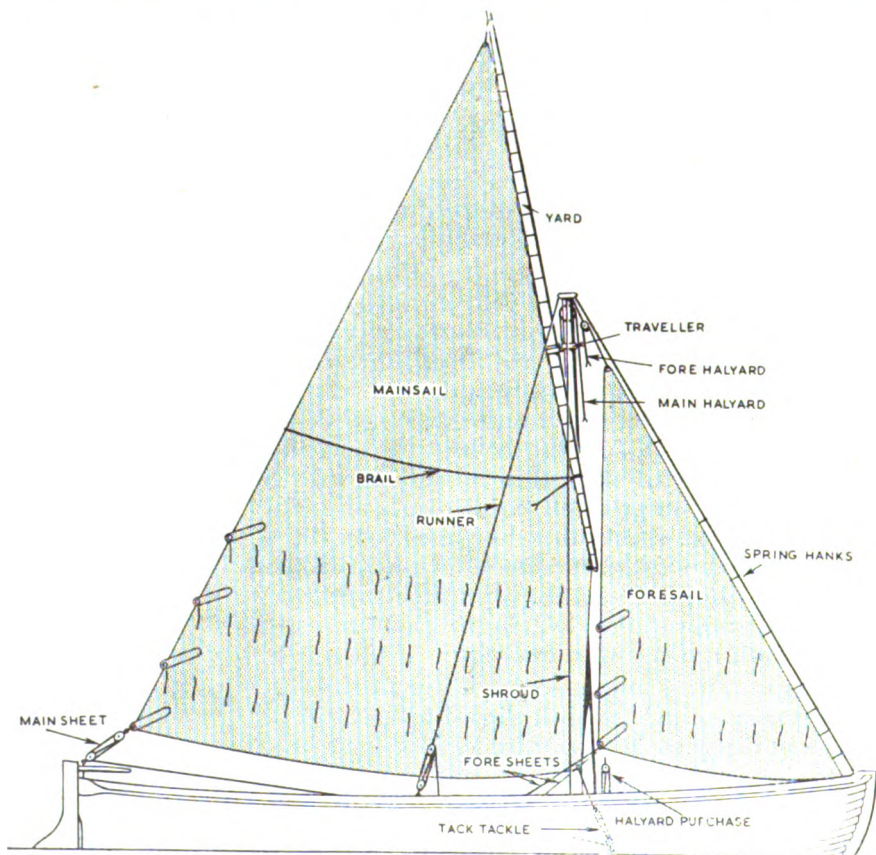


Fig. 183. Sailing rig of a 32-ft. cutter

boom and lash it in place with the topping lift ; they then unship the mizzen-mast and lay it to one side of the thwarts, then unship the rudder, yokes, yoke-lines and tiller and lay them in the sternsheets. Nos. 3 and 4 lay hold of the mainmast, No. 2 unclamps it, and then all three lift it clear of its step and lower it to stroke and the coxswain. No. 4 raises the drop keel. The foresail, spinnaker, sheets, tackles and any other loose gear are handed to stroke who stows them in the boat's sailing bag.

Sailing Rig of 32-ft. Cutter (Fig. 183)

The rig illustrated is called sloop rig, this being the general term used for a boat rigged with a foresail and standing-lug mainsail.

The mast is stepped, through a hinged iron hoop on the third thwart, into its step in the keelson where it is locked in place by a hinged shoe ; it is stayed by two shrouds, two backstays (commonly called "runners") and a forestay, all of wire rope. The heads of the shrouds, runners and forestay are shackled to a spider band at the masthead ; the shrouds and forestay are set up by lanyards, the former to chain-plates inside the gunwales and the latter to a long shackle on the stem-head, the runners are set up, abaft the shrouds, by the runner tackles to chain-plates and cleats inside the gunwales. The weather runner is always set up taut, and the lee runner eased to allow the sail to take up its natural belly.

The sails comprise a foresail, mainsail, a storm trysail or spinnaker, and storm foresail. Spreaders are provided for bearing out the feet of the mainsail and trysail. The foresail can be double-reefed, and the mainsail treble-reefed.

The main halyard is a wire rope pendant rove through a sheave at the mast-head. One end is shackled to the traveller, and the other tailed with a double-whip ; the standing block of the whip is shackled to a spider band on the mast just above the thwart, the hauling part being rove through a leading block on the same band and set up to a belaying pin under the fifth thwart. The tack of the mainsail is bowed down by a tack-tackle rove to an eyebolt in the keelson at the foot of the mast.

The fore halyard is a double-whip, the standing block of which is shackled to the spider band at the masthead and the moving block to the head of the foresail.

The mainsheet is a jigger, the single block of which is hooked to the clew of the mainsail with a tack-hook, and the double block of which is hooked to the horse.

The two foresheets each consist of two parts, one sheet being rove on each side of the boat ; the standing part of each is secured to the rising abaft the mast thwart, then led through a bullseye on the clew of the foresail and then aft through a lizard bullseye secured to the rising abaft the standing part.

The luff of the foresail is hanked to the forestay. A running-hook is provided on the gunwale on each bow to which the tack of the foresail is hooked when the boat is running before the wind. The mainsail is fitted with brails led through bullseyes on a strop at the throat of the yard.

Sail Drill for 32-ft. Cutter

The crew of 12 men are detailed as follows :—

- bow thwart — Nos. 1 and 2 (the bowmen) ;
- 2nd thwart — Nos. 3 and 4 ;
- 3rd thwart — Nos. 5 and 6 ; and so on to the
- stroke thwart — Nos. 11 and 12 (the stroke oarsmen).

The mast is laid along the centre of the thwarts, heel forward, the main yard and mainsail are laid to starboard of the mast, peak aft, and the boat's sailing bag is placed in the sternsheets. All poppets are shipped and the oars are secured each side in their becketts.

At the order " Clear away rigging " :—

- Nos. 1 and 2 clear away the forestay ;
- Nos. 3 and 4 clear away the shrouds ;
- Nos. 9 and 10 clear away the runners ;
- Nos. 5, 6, 7 and 8 lift and launch the mast aft and place its heel through the hinged mast hoop ;
- Nos 11 and 12 ship the horse, secure the rudder lanyard in the boat, and ship the rudder and sailing tiller.

At the order " Up mast, rig the boat " :—

- Nos. 1 and 2 tend and haul on the forestay ;
- Nos. 9 and 10 tend the runners ;
- Nos. 5, 6, 7 and 8 lift up the mast and step it ;
- No. 5 replaces the shoe in the mast step ;
- Nos. 1, 2, 3, 4, 9 and 10 set up the shrouds, runners and forestay.

The running rigging is then rove as follows :—

- Nos. 1 and 2 hook the tack of the foresail to the tack-hook, and hank the luff to the forestay ;
- No. 3 clears away the fore halyard and bends it to the head of the foresail ;
- No. 4 bends on the foresheets and reeves them on each side, and then reeves the brails ;
- No. 5 rigs the tack-tackle, overhauls it and hooks it to the tack of the mainsail ;
- No. 6 clears away the main halyard ;
- Nos. 7, 8, 9 and 10 remove the mainsail from its cover, clear it away, and hook the strop on the yard to the traveller ;
- Nos. 11 and 12 shackle the mainsheet to the horse and hook the running block to the clew of the mainsail ;
- No. 3 hoists the foresail to ensure that it is clear, and then lowers it ;
- Nos. 6 and 7 hoist the mainsail and set up and belay the halyard ;
- No. 5 bowses down on the tack-tackle and belays it ;
- No. 4 brails up the mainsail.

If the spinnaker is to be used :—

- Nos. 5 and 6 clear it away, No. 4 reeves the halyard and hooks on the tack to the hook on the mast, and No. 6 bends on the sheet and provides the bearing out spar.

When under way :—

- Nos. 1 and 2 keep a lookout and tend the forestay, the foresail and its tack. Nos. 3 and 4 tend the fore halyard and brails respectively, see that

the shrouds are set up and the running rigging on the mast clear, and tend the tack-tackle. If the spinnaker is set No. 4 tends its halyard and tack, and Nos. 5 and 6 tend its sheet and bearing-out spar. Nos. 5 and 6 tend the fore sheets, Nos. 7 and 8 tend the drop keel and the main halyard, Nos. 9 and 10 tend the runners and gather the foot of the mainsail when brailing up. Nos. 11 and 12 tend the mainsheets and the clew of the mainsail.

At the order " Down sails, stow gear " :

No. 3 lowers the foresail, which is gathered by Nos. 1 and 2 who unhook the tack and sheets, unhook the sail from the forestay, and fold it up if dry. No. 4 unreeves the foresheets and makes them up. No. 6 lowers the mainsail, which is gathered by Nos. 7, 8, 9 and 10 who unhook it from the traveller, fleet it aft, and, if dry, fold and roll it, lash it up with the brails and stow it in its cover. Nos. 11 and 12 unhook the mainsheet from the clew, unshackle it from the horse and make it up; they then unship the horse, rudder and tiller. No. 3 hooks the fore halyard and traveller to the becket on the mast and he and No. 4 then unreeve the shrouds. Nos. 9 and 10 cast off the runners and pass them to Nos. 3 and 4, who make them up round the mast by crossing them alternately and lashing them in place with the shroud lanyards, No. 5 unhooks the tack-tackle and makes it up. Nos. 1 and 2 cast off the forestay and stand by to lower the mast on it. The spinnaker, if used and if dry, is folded and lashed with its sheet and halyard by Nos. 5 and 6.

Nos. 7 and 8 haul up the drop keel.

At the order " Down mast " :

Nos. 1 and 2 tend the forestay, No. 2 unlatches the shoe in the mast step, Nos. 4, 5, 6 and 7 lift the mast out of its step and lower it to Nos. 9, 10, 11 and 12, being assisted by Nos. 1 and 2 on the forestay. The mast is then launched aft clear of its hoop and placed down the centre of the boat, and the forestay is then lashed to it with its lanyard. The sheets, tackles, shackles, foresail, spinnaker and any loose gear are stowed in the boat's sailing bag by Nos. 11 and 12.

Description and Rig of 27-ft. Surf Boat (Fig. 184)

This is a double-diagonal-built pulling and sailing boat, of similar dimensions and weight to the 27-ft. whaler but especially designed for landing in a surf.

The gear and fittings differ from the 27-ft. whaler in the following respects:—

Two sets of oars are provided, a single-bank set of 5 for normal purposes and a double-bank set of 10 shorter oars for pulling through surf, together with a long steering oar. The crutches are of special shape to prevent the oars jumping out of them in a rough sea and they can be stowed without removing them from their sockets.

The boat is gunter-rigged, *i.e.* she has a foresail and an almost triangular gaff-mainsail with the gaff topped close to the mast, and the foot of the mainsail is bent to a boom.

A rotary bilge pump is provided in addition to hand bailers; a water-tight locker is provided each side amidships for the stowage of surveying instruments; the stretchers are of half round section so that they may be placed below the keel when hauling the boat up a beach; a hole (called a "riffle") is drilled at each end of the keel to take a long shackle for the

hook of a purchase for hauling the boat up a beach ; a bollard is provided on each quarter for working the drogue warp when running before a heavy sea or through surf, and lumber irons are provided for stowage of spars.

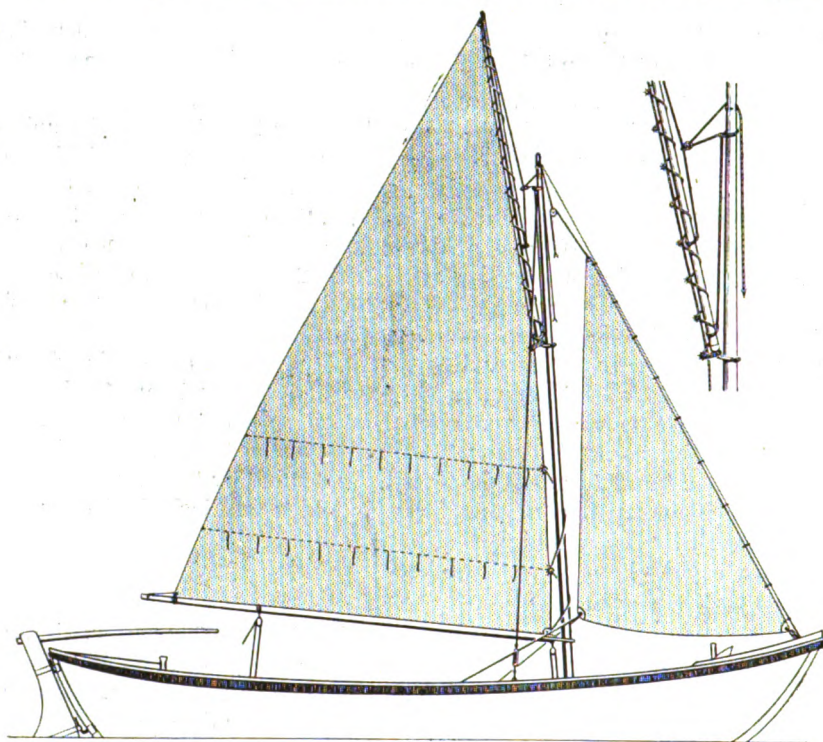


Fig. 184. Sailing rig of a 27-ft. surf boat

In addition to the normal foresail and mainsail a "Genoa" jib, a storm trysail and a storm foresail are provided. In a rising wind sail may be shortened progressively by first hoisting the storm foresail instead of the foresail, then taking down reefs in the mainsail, and, lastly, by hoisting the storm trysail in place of the mainsail.

The mast is stayed by a forestay and two shrouds of wire rope, and is stepped through a clamp on the mast thwart and a hole in the floorboards into the keelson. The upper ends of the forestay and shrouds are fitted with soft eyes which are placed over the head of the mast, and their lower ends are fitted with rigging slips ; the shrouds are also fitted with bottle screws by which they are set up. The rigging slips are locked with split pins, which should always be inserted when the sailing gear is rigged.

The fore halyard is a single-whip rove through a block on a pendant at the masthead. The eyes of the fore halyard pendant, fore stay and shrouds are placed over the head of the mast in that order.

The gaff of the mainsail is fitted with a wire span, on which is shackled a bullseye. The main halyard is a double-whip with its standing end secured to the throat of the gaff ; it is rove through a bullseye on a strop at the masthead, down through the running bullseye on the span of the gaff, back round the sheave at the masthead, and down to its belaying pin in the mast thwart.

When the storm trysail is used the running bullseye is shackled to its head and the standing part of the main halyard is made fast to the mast thwart.

To the heel of the boom is shackled a tack-tackle, the standing block of which is shackled to a ring in the floorboards just abaft the mast. When bowsed down it is belayed by hitching the hauling part round the running parts.

The head of the mainsail is laced to the gaff with a spiral lacing, and its luff is laced to the mast as shown in Fig. 184. The tack is hooked to the heel of the boom, and the clew to the hook of an outhaul fitted to the end of the boom ; in light winds the foot of the sail should be fairly slack to allow the sail to belly out ; but in strong winds the foot should be hauled out fairly taut.

The foresheets are rove through eyebolts fitted to each gunwale, and thence to jamming cleats fitted on each side of the sternsheets. Two fairleads abaft the foresheet fairleads are provided for the sheets of the Genoa jib.

The mainsheet is a jigger, the standing block of which is shackled to a ring in the floorboards of the sternsheets, and the other to a strop on the boom whence the hauling part is led round a cleat on the floorboards and tended. The storm trysail is fitted with separate sheets the blocks of which are hooked to eyes on the quarter bollards.

The centre-board is raised and lowered by a small tackle on the starboard side of the keel box.

Description and Rig of 14-ft. Sailing Dinghy (Fig. 185)

This boat is a modified version of the original International Class 14-ft. racing dinghy, strengthened for sea service and supplied to H.M. ships for instructional, recreational and general purposes. The hull is clinker built and varnished.

Because of its light construction this boat should be treated with great care, especially when being hoisted in and out and stowed, and it should not be left at the lower boom for longer than necessary. The hull should be kept varnished, not painted. The boat is sufficiently robust for general duties of a light nature, but being designed primarily as a sailing boat she is not so good under oars as are the standard Service pulling boats ; she will pull better if the keel is lowered a little.

The rig comprises a foresail and a gunter-mainsail, and being essentially a racing rig with yacht quality gear it should be given every care and attention and kept tuned to racing pitch.

The forestay and the two shrouds are of wire rope and fitted with bottle screws and rigging slips. The fore halyard is a single whip rove through a block on a masthead pendant. The gaff is fitted with throat and peak halyards ; the throat halyard is shackled to the throat of the gaff, rove through a block at the masthead, and belayed to a pin in the mast thwart ; the peak halyard is shackled to a roller running on a wire span fitted to the gaff, and is rove through a block at the masthead and belayed to a pin in the mast thwart.

The heel of the gaff is connected by a swivelling connection to a traveller on the mast. The heel of the boom fits over a gooseneck pin clamped to the foot of the mast, thus enabling the sail to be reefed by revolving the boom so that it winds the foot of the sail around it ; the heel is bowsed down by a lanyard secured to an eyebolt near the heel of the mast, so that the boom is kept in place on its gooseneck pin.

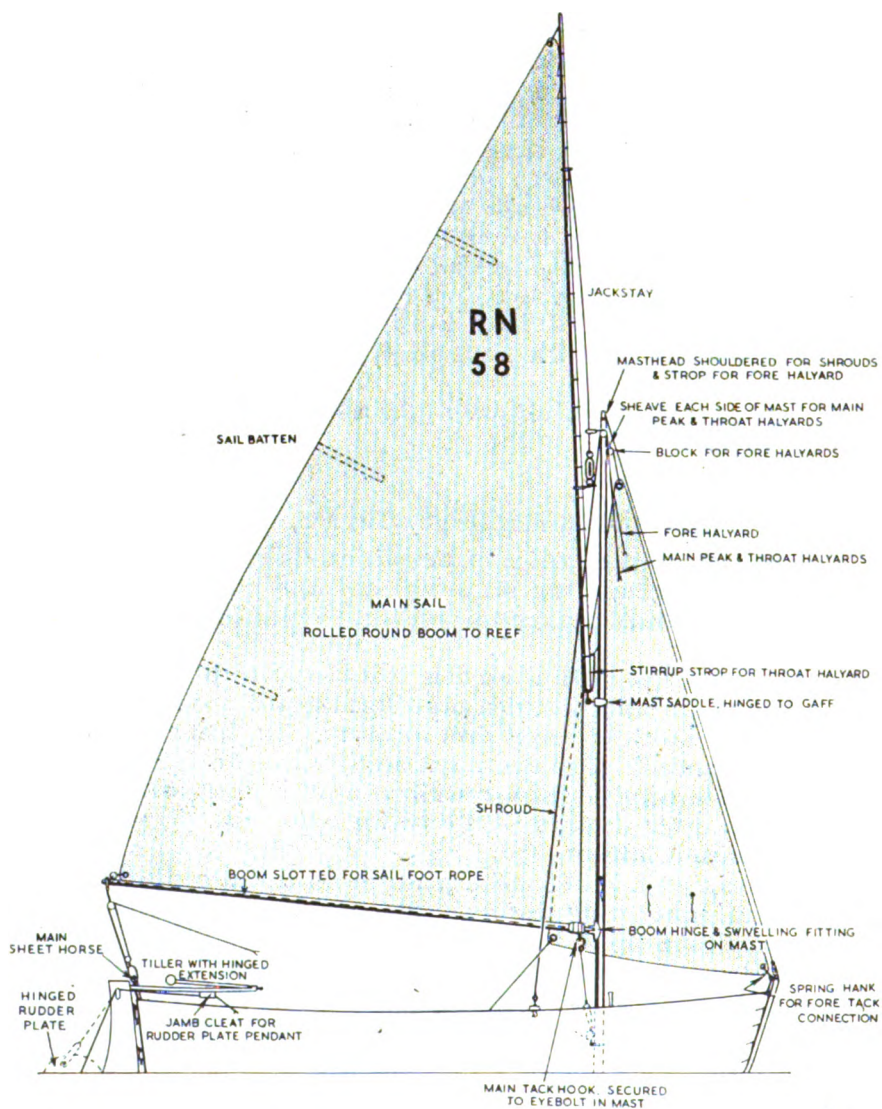


Fig. 185. Rig of a 14-ft. sailing dinghy

The luff of the foresail is hanked to the forestay ; the toresheets are rove through fairleads in the sides of the boat and can be belayed on jamming cleats abaft the fairleads. The head of the mainsail is laced to the gaff, and its foot-rope is secured in a slot in the boom ; its curved leach is fitted with three wooden spreader battens. The mainsheet is a jigger with its single block running on a horse fitted on the transom.

The rudder post is fitted with a hinged rudder plate to which is attached a pendant by which the plate can be raised when the boat is running free or in shallow water, and lowered when beating to windward. The tiller is fitted with a hinged extension piece to allow the helmsman to steer from amidships.

The centre-board is raised and lowered by a small winch fitted near the heel of the mast, the end of the winch rope being belayed to a cleat on the keel box.

The mainsail is reefed by settling the throat halyard and then rotating the boom so that it winds the sail around it, the luff being kept close to the heel and the leach hauled out to the head of the boom to ensure that the foot remains straight and uncreased. The boom is then secured by making fast its lanyard to the mast below its heel.

BOAT SAILING

Terms used in Sailing

Close-hauled. A boat is "close-hauled", or sailing "by" or "on the wind", when all her sails are drawing and she is sailing as close as possible to the direction from which the wind is blowing. Few Service boats will sail to advantage when heading closer than about $4\frac{1}{2}$ points (50°) from the direction of the wind.

Sailing free. A boat is sailing free whenever her sails are filled and she is not sailing close-hauled ; *i.e.* when sailing so that she is free to manoeuvre on either side of her course without having to go about.

Reaching. A boat is reaching when she is sailing free with the wind abeam or before the beam, but is not sailing close-hauled. She is on a "close reach" or "fetching" when she is nearly close-hauled, and on a "broad reach" when the wind is abeam ; and she is said to have a "soldier's wind" if she can sail to her destination on one tack and return from it on the other tack.

Running. A boat is running when she is sailing with the wind abaft the beam.

Port and starboard tacks. When either close-hauled or reaching a boat is on the "port tack" when she has the wind on her port side, and on the "starboard tack" when she has the wind on her starboard side.

Tacking, or going about. A boat tacks or goes about when she changes from one tack to the other by altering course into the wind and then away from it on the opposite tack. The order "ready about" is the warning given to the crew to stand by to tack.

Beating. A boat is beating when she works close-hauled to windward in a series of alternate tacks.

Wearing. A boat wears when she changes from one tack to the other by turning her head away from the wind and bringing her stern up into it, then gybing and bringing her head towards the wind again but on the opposite tack.

Port and starboard gybes. When a boat is running she is said to be on the "port gybe" when the wind is blowing on her port side from abaft the beam and her mainsail is set to starboard, and she is said to be on the "starboard gybe" when the wind is blowing on her starboard side from abaft the beam and her mainsail is set to port.

Running by the lee. A boat is running by the lee when she is running with her mainsail set on the windward side; she is then very liable to gybe, which is dangerous in strong winds.

Brought by the lee. A boat which is running before the wind is said to be brought by the lee when the wind suddenly changes from one quarter to the other; this often happens in squally weather owing to a shift of wind, but may also be due to a sudden yaw caused by bad steering.

To gybe. A boat which is running before the wind gybes when, either purposely or accidentally, the mainsail is brought or blown across to the opposite side of the boat. A boat therefore gybes when she wears, or if she is brought by the lee.

To miss stays. A boat misses stays when she fails to go about from one tack to the other and pays off on her original tack.

In irons. A boat is in irons when she fails to go about from one tack to the other and lies head to wind unable to pay off on either tack.

The helm. In directing the steering of a sailing vessel the tiller is referred to as the helm, and in directing its movement reference is made to the weather or lee side of the vessel, *i.e.* to the upper or lower side, respectively; thus, at the order "Up helm", the tiller is moved towards the weather or upper side of the boat, and at the order "Down helm" it is moved towards the lee or lower side. When the helm is put up the bows will pay off from the wind, and when put down the bows will turn towards the wind; the order "Bear up" is also used, and has the same meaning and effect as "Up helm". A boat is said to carry "weather helm" if, with the helm a'midships, she tends to fly up into the wind; and she is said to carry "lee helm" if, with the helm a'midships, she tends to pay off from the wind.

"*Keep away*" is an order to the helmsman to allow the bows to pay off from the wind; it is used instead of "bear up" when the movement required is not so drastic.

"*No higher*" is an order to the helmsman to steer no closer to the wind.

"*Nothing off*" is an order to the helmsman not to allow the bows to pay off any further from the wind.

To weather an object is to pass it on its windward side.

To luff is to bring the boat's head closer to the wind.

Flat aft. The sails are said to be flat aft when they are sheeted home as tautly as possible.

To back a sail. A sail is said to be backed when it is trimmed to catch the wind on its fore side, and so tends to stop the boat's headway and drive her astern.

Flat aback. A boat is said to be taken flat aback when, owing to a sudden shift of wind or alteration of course, the wind suddenly fills the sails on their wrong side and so reduces the boat's speed or gives her sternway.

The larger component AE acting on the sail tends to heel the boat over, but this tendency is largely overcome by the inherent stability of the boat, which resists it, and by stationing her crew to windward and so increasing her resistance to heeling. The component AE also tends to drive the boat bodily to leeward, but this tendency is largely overcome by the provision of a drop keel and by the resistance of the water on the side of the boat's hull.

The smaller component AF is employed in propelling the boat ahead, and in this it is assisted by the shape of the boat's hull, which offers the least resistance to the water when the boat is moving directly ahead.

If now the course of the boat is altered to bring the wind abeam, and if the trim of the sails is not altered, the lateral force tending to heel the boat over and drive her to leeward will be appreciably greater than that shown in Fig. 186 and she will probably be blown over on her beam ends.

If, however, the sheets are checked so that the sail takes up the position shown in Fig. 187 the lateral component of the wind's force AE will be reduced, while the forward propelling component AF will be increased and the boat will move faster ahead than when the wind was on her bow.

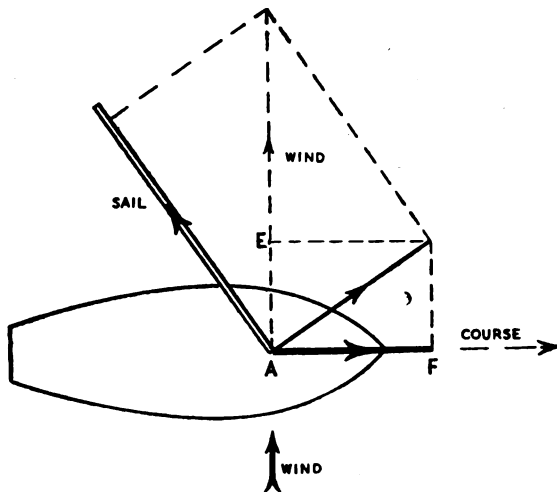


Fig. 187. Action of wind on the sails of a boat, II

If this line of reasoning were carried a step further (by altering the course of the boat to bring the wind aft and by trimming the sails to the most effective angle with the wind), it would appear that the boat would move ahead still faster because of the further increase in the forward propelling component and the consequent reduction in the lateral component. This is not so, however, because so far we have only considered the effect of a steady wind on a boat at rest, whereas, in fact, her speed must be taken into account in order to determine the effective power of a wind to drive the boat ahead.

If, for example, a boat is running at say 4 knots before a true wind of 10 knots (as in Fig. 188 (a)), the effective wind acting on her sails to drive her ahead is only 6 knots. When the wind is abeam, however (as in Fig. 188 (b)), the effective wind is 10 knots, and though not all of it is employed in driving the boat ahead it will usually give the boat a greater speed than 4 knots. When

the wind is on the bow (as in Fig. 188 (c)), although the effective wind is greater than 10 knots, its forward driving component is so reduced that the boat's speed will be much less than 4 knots.

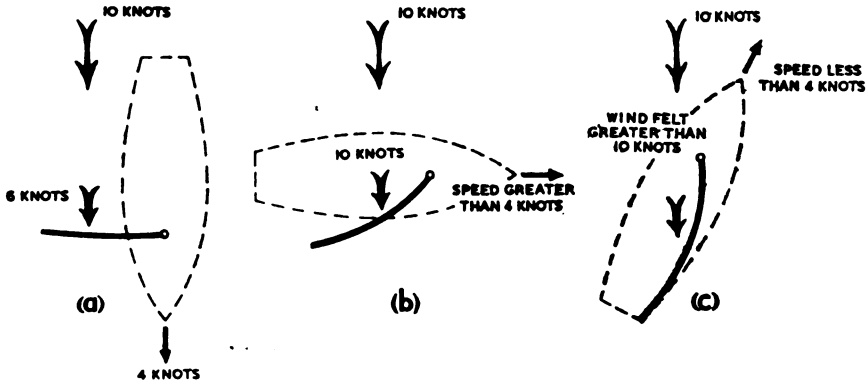


Fig. 188. Action of wind on the sails of a boat, III

A boat's speed is therefore greatest when she is reaching and least when she is sailing by the wind; and when running she will sail faster with the wind on the quarter than with the wind right aft. Though these deductions are dependent upon the shape of the boat they are true of most modern sailing craft and, generally speaking, of all Service boats.

When the angle between the plane of the sails and the direction of the wind becomes less than what is known as the "critical angle" the sails will no longer hold the wind and its forward driving power will be lost. This critical angle differs with the rig and shape of the boat, and no two boats are exactly alike in this respect. In general it can be said that few Service boats will sail closer than $4\frac{1}{2}$ points (50°) from the wind, but when deciding the course to steer in order to weather an object an addition must be made to this $4\frac{1}{2}$ points to compensate for any leeway when beating or reaching. As a very rough guide a boat should be able to weather an object on the opposite tack if she goes about when it bears about 3 points abaft the beam, but no hard and fast rule can be laid down because so much depends upon the skill of the helmsman, the set and trim of the sails, the trim of the boat, the strength of the wind and the state of the sea.

Pivoting Point (Fig. 189)

Imagine the boat to be pivoted about a fixed and vertical pivot at some point along her keel, and floating broadside on to a steadily flowing current; if then she shows no tendency to swing in line with the current she will be balanced about her pivoting point. If, however, she is now trimmed deeper by the bows or the stern she will present a larger area of her hull to the current before or abaft her pivot, respectively, so that she will be swung into line with the current unless the pivot is moved forward or aft to preserve her balance.

Now imagine a strong breeze blowing in the same direction as that in which the current is flowing; if the areas of the boat's freeboard before and abaft her pivot are unequal she will be swung by the wind in line with wind and current unless the pivot is shifted forward or aft the required distance to keep her balanced.

From these examples it will be seen that the pivoting point of a boat changes its position in accordance with her trim.

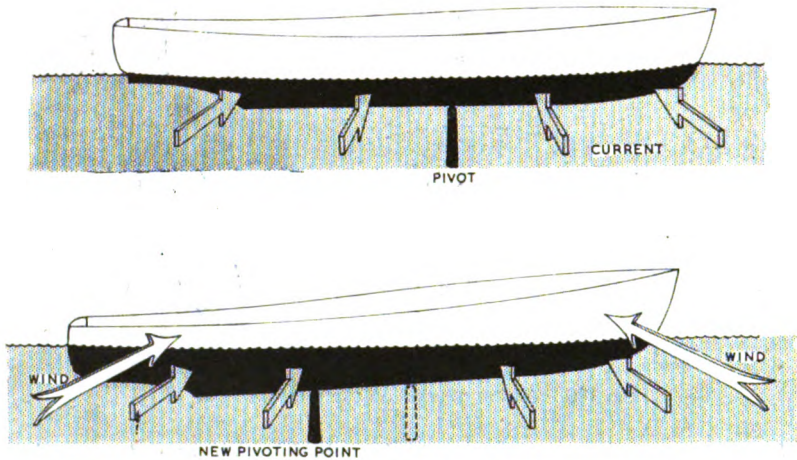


Fig. 189. Pivoting point of a boat

Centre of effort of Sail Area

The centre of effort of any one sail is that point at which the driving force may be presumed to act (points A and B in Fig. 190). This point will shift in accordance with the trim of the sail and the angle between the plane of the sail and the direction of the wind. By combining the centres of effort of each sail the centre of effort (C of E) of the total sail area can be obtained (X in Fig. 190).

The centre of a boat's lateral resistance (CLR) is at some point below the waterline and in line with her pivoting point (Y in Fig. 190). It will shift as the trim of the boat alters in the same manner as does the pivoting point.

In a well designed vessel the centre of effort of the sails should be as nearly as possible over her centre of lateral resistance, but, because both are continually changing their position with the trim of the sails and of the boat, this cannot actually be achieved. If the centre of effort is abaft the centre of lateral resistance (as illustrated in Fig. 190) the boat will tend to come up into the wind, and if before it she will tend to pay off from the wind. These tendencies can be countered by using the rudder, altering the trim of the boat, or altering the trim of the sails, and in practice all three are used continuously as the boat beats, reaches, or runs.

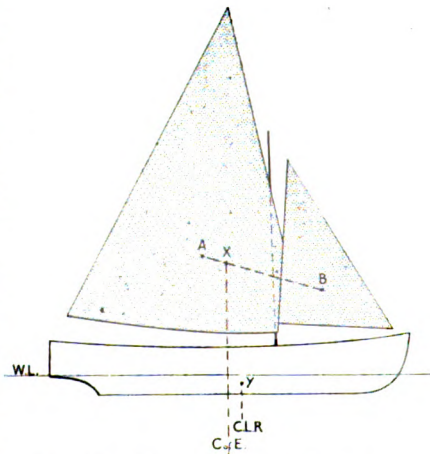


Fig. 190. Centre of effort of sail area and centre of lateral resistance

Use of Rudder

A boat which tends to luff when the helm is a' midships is said to carry "weather helm", and a boat which tends to pay off is said to carry "lee helm". The rudders of most Service boats do not project below the keel, and the more the boat heels over in a strong breeze the less the rudder is immersed and the less effective it therefore becomes. A boat carrying lee helm is therefore in danger of broaching to and capsizing in a squall, because when she heels over to the wind her rudder will be unable to counter her tendency to pay off broadside on to the wind. On the other hand if a boat carrying weather helm is hit by a squall she would come up into the wind and so spill the wind from her sails. It is therefore always advisable in a Service boat to carry a certain amount of weather helm, but it should be borne in mind that the speed of a boat carrying any helm will be reduced by the resistance of the rudder to the flow of water past it.

To give maximum effect to the rudder the crew should sit well to windward when beating or reaching so that the boat will heel to leeward as little as possible, and the boat may also be trimmed slightly by the stern by moving the crew further aft.

When altering course or going about the helm should be eased over gently so as to "sail the boat round"; if it is suddenly put over, or if too much helm is used, the rudder will take the way off the boat and she will fail to answer her helm.

Trim of Boat

The trim of a boat has a great effect on her sailing qualities and seaworthiness. Beating, reaching or running, light or strong winds, calm or rough seas, and deep or light loading, each require an adjustment of trim, and this adjustment is effected by shifting her ballast, which, in Service boats, consists of her crew and her water barriques.

Generally speaking a boat should be trimmed as nearly on an even keel as possible; if she needs much trimming to make her sail well there is something wrong with the shape of her hull, her rig, or the disposition of the weights in her. The best trim for any given circumstances can be found only by experience and the following remarks are given only as a general guide.

Stores, passengers and other cargo should not be carried in the ends of the boat because they would then so reduce the buoyancy of her bows and stern that she would not rise with the waves; she would therefore probably ship water over the bows when beating or reaching, or be pooped by a following sea when running, and excessive weight in the ends of a boat will also make her sluggish in answering her helm. When a boat is beating or reaching, undue weight in the bows will make her luff up, and undue weight in the stern will make her pay off. When a boat is running undue weight in the bows will make her luff and may cause her to broach to and capsize.

When beating or reaching weather helm can therefore be corrected by trimming the boat by the stern, and lee helm by trimming her by the head. When running a boat tends to bury her bows, and this should be corrected by trimming her by the stern.

If a boat pitches heavily in a head sea she may require trimming by the head to steady her and prevent her paying off; trimming her by the head will also lessen the chance of missing stays when going about.

Heavy stores and water ballast in barricoes should be placed amidships, low down and as near the centre-line as possible, and space should be left for baling ; any correction to trim should be made by moving the crew about the boat.

No " dead " ballast, such as lead, pig iron, stones or shingle, or water in bulk, is allowed in an open boat because it reduces her reserve of buoyancy and is difficult to jettison in emergency, and water in bulk reduces her stability as well.

Set of the Sails

The set of a boat's sails is almost as important as their trim, and the chief factor in setting any sail is that its luff should always be set up taut.

In a standing lugsail the position of the strop on the yard is all-important. It should be placed at about one-third of the length of the yard from its throat, but exactly the best position can be found only by trial and error ; by moving it towards the throat the yard will set higher and closer to the mast, but if it is moved too near the throat the downward pull of the tack-tackle will give insufficient leverage on the yard to keep the leach taut. When the correct position of the strop is found it should be secured in place by thumb pieces screwed to the yard on each side of the strop. When the yard is hoisted and the tack-tackle set up a crease will be formed between the throat and the clew, but it will disappear when the sail is filled. When hoisted the foot of the sail should be just clear of the gunwale or washstrake.

The correct lead of the foresheets is also important. There should be a sufficiently wide gap between the leach of the foresail and the luff of the mainsail to allow the wind to flow freely between them, as shown in Fig. 191 (a) ; in Fig. 191 (b) the foresail is not sheeted sufficiently far outboard. Fig. 191 (c) shows the lead of a long-footed foresail, such as the Genoa jib which is particularly effective when reaching or beating in light winds.

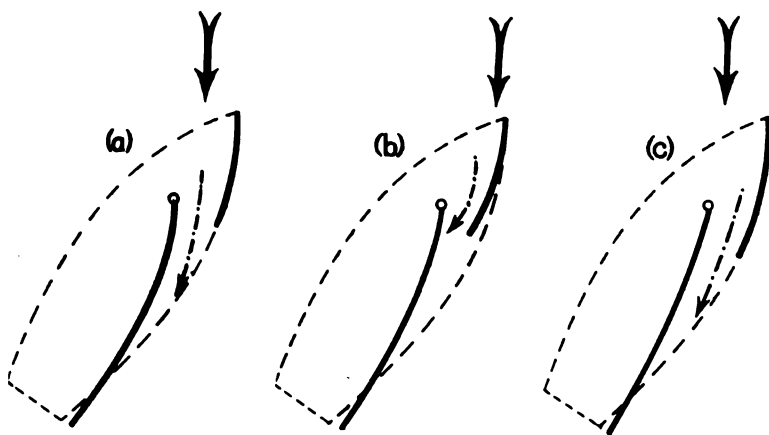


Fig. 191. Lead of foresheets

If the sheets are led too far aft the foot of the sail will be too taut and the leach too slack, and if led too far forward the leach will be too taut and the foot too slack. When correctly led a projection of the line of the sheet across the sail should approximately bisect the angle of the clew, and the pull of the sheet should tend to tauten the leach rather than the foot.

A mainsail is cut to set in a slight curve or camber, whose greatest depth is just abaft the luff. Where a mainsail is bent to a boom the set of the foot can be altered by easing away the clew cringle and the foot lacing. The sail should be allowed its full curvature when on a reach, but should be set fairly flat when beating.

Trimming the Sails

The strength and direction of even a steady wind is continuously altering, and the art of sailing a boat lies mainly in paying constant attention to its slightest change and then altering course and trimming the sails to meet it. In a steady wind the fore- and mizzensheets may occasionally be belayed, but the mainsheet should *always* be in hand.

Beating, Going about, Reaching, Running and Wearing

When beating, the sheets should be hauled well aft and the boat steered as close to the wind as she will go without the luff of her mainsail shaking. If the sheets are hauled too flat aft the sails will not hold the wind and the boat will lose way; the sails can be set flatter in a high wind than in a light wind, but they can also be set flatter in calm water than in rough water. When sailing on a wind the luffs of the sails should be just not shivering; to achieve this, first trim the sails correctly, then ease the helm down until the luffs start to shiver, then ease the helm up until they are again steady, and keep the boat on that course.

Going about. Before going about from one tack to the other the boat should be paid off a little so as to gather enough way to enable her to fore-reach through the wind; the helm should then be eased gently down and the boat "sailed" through the wind on to the other tack. As the helm is put down the mainsheet should be hauled aft and the foresheet checked slightly, and as the bows pass through the eye of the wind the foresail should be backed by hauling aft the windward foresheet, and the mainsheet should be checked; this helps the boat to cast on the other tack. As soon as it is certain that the bows will pay off on the new tack the order "Let draw, aft mainsheet" should be given, the lee foresheet and the mainsheet being hauled aft at the order. If, as the bows come up to the eye of the wind, it appears doubtful that the boat will go about, the crew should immediately be flattered aft to the old weather quarter (thus lightening the bows) and the foot of the foresail should be held out towards the old lee bow; if the boat then gathers sternway the helm should be reversed and the mainsheet checked. When clawing off a lee shore, or when missing stays might be serious, an oar should always be kept ready to pull the bows round if required; this is the only occasion when oars may be used while under sail, because the lee oars may be caught in the water through the heeling of the boat, and may then split her gunwale or even capsize her.

When reaching keep the boat on as even a keel as possible by distributing the crew to windward evenly between the head and stern sheets, and trim the boat to carry a little weather helm. Check the sheets until the sails start to shiver, then haul them in a little so that the sails are well filled and taut. Lee or weather helm is best corrected by trimming the boat, but either can be corrected to a certain extent by trimming the sails; to correct lee helm haul aft the mainsheet and check the foresheet, and to correct weather helm check the former and haul aft the latter.

In a light wind bear out the foot of a loose-footed sail, as illustrated in Fig. 192 (b), so that the wind will fill it ; if the clew of the foresail is hauled too far aft by its sheet there will be insufficient space for the wind to flow freely between it and the mainsail and the latter will not draw correctly (see Fig. 192 (a)).

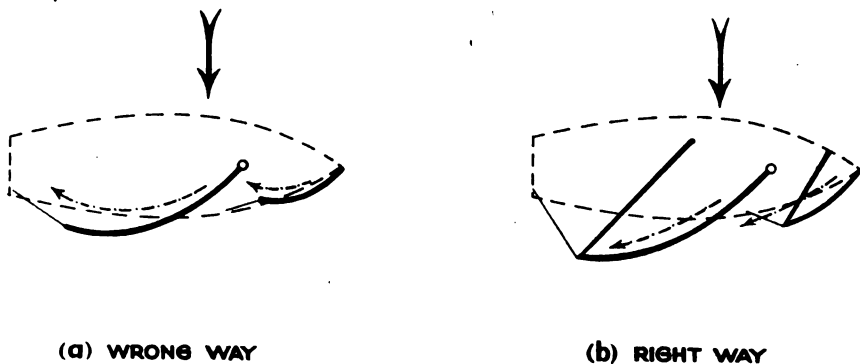


Fig. 192. Trim of sails when reaching

When running shift the fore tack to the running-hook, and, if rigged with loose-footed sails, bear their feet out at the clews with bearing-out spars.

The sails should be set so that their plane is at right angles to the direction of the wind (see Fig. 193). If the boat is running nearly dead before the wind the sails may be goose-winged, but running dead before a strong wind and a following sea should be avoided whenever possible because the boat then tends to yaw uncontrollably and perhaps gybe, broach to and capsize. If your destination lies directly down wind it is best to steer for it on a zig-zag course so as to keep the wind well on the quarter ; no time will be lost by sailing the extra distance involved because the boat will sail faster with the wind on her quarter than with the wind right aft.

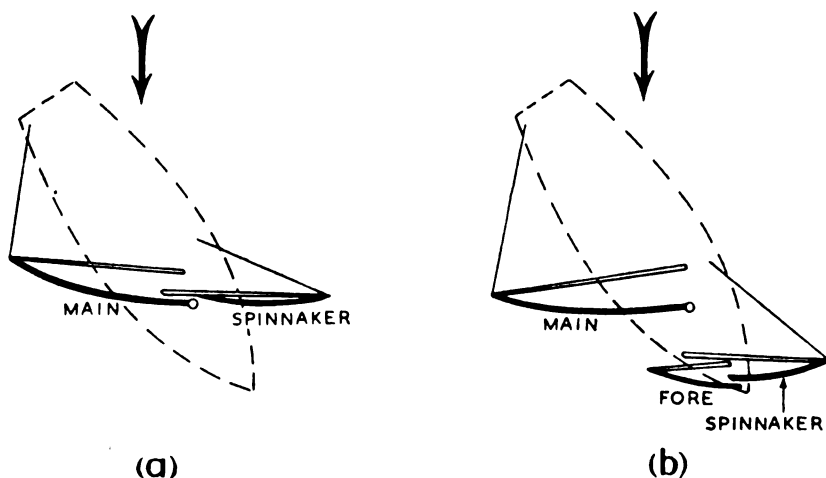


Fig. 193. Trim of sails when running

If a boat is rigged with a mizzen it should be furled when running before a strong wind, because if set it will make her yaw. If necessary to shorten sail the mainsail should be furled in preference to the foresail. A boat carrying too much sail when running will be sluggish to handle, and drive down into the water so that she tends to bury her bows; should any such tendency occur sail should immediately be shortened or she may drive under.

When running before a strong wind and heavy sea, stream a drogue to prevent the boat from riding on the crest of a wave; this will also steady her and keep her from yawing (see Fig. 214 on page 324). If a drogue is not available, stream a long bight of the boat's cable, or bend a line to an oar, a small sail, or a grating, and tow it astern.

Wearing is the reverse of tacking, the boat changing from one tack to the other with the stern passing through the wind. To wear, the helm should be eased up gently and the sheets checked until just before the wind is right aft, when the mainsail should be brailed up if it is loose-footed and the foresheet be hauled aft. As soon as the wind is on the other side the mainsail should be set and the foresheet checked; as the mainsail then fills on the new tack the boat will tend to luff up, and the helmsman should remember that if this is not met by bearing up the helm the boat may broach to. In a light wind it is not necessary to brail up, but the mainsheet should be hauled aft roundly just before the wind is right aft, and checked roundly as soon as the wind is on the other side of the sail. With a boom-mainsail the mainsheet should be hauled aft as the helm is eased up, and checked roundly as soon as the wind is on the other side of the sail. It is essential to avoid gybing heavily in a vessel rigged with a boom-mainsail, because the weight of the boom swinging across out of control may carry away the shrouds or backstays and heel the vessel over before the crew have had a chance to trim her on the opposite tack, in which case she may broach to and capsize. In a strong wind the boom should be topped up when wearing, but in large boats this is impracticable because of the weight of the boom.

Handling in Rough Weather

When struck by a squall the sheets, particularly the foresheet, should at once be let fly or roundly checked, and the helm should then be eased down to luff the boat up and so spill the wind out of her sails; the sheets can then be hauled aft and the boat paid off as necessary to continue on the original course.

A reef should be taken down as soon as the boat begins to get "wet", i.e. when water begins to splash over the lee gunwale. To take down a reef the boat should be luffed up sufficiently to spill the wind from her sails, and the halyards should then be settled and the tack hooks and sheets shifted to the reef cringles. The foot of the sail should be gathered up, not rolled, and then be stopped by passing the reef points tautly round it. (A roll forms the neatest reef, but it catches any water and holds it.)

A reef is shaken out by luffing the boat as before, and then unbending the reef points, settling the halyards and shifting the tack hooks and sheets to their proper cringles.

If a Service sailing boat capsizes or is swamped the crew should remain with the boat, because she will remain floating, even though awash, and have a sufficient reserve of buoyancy to support her crew.

If possible, her standing and running rigging should be cut or cast off, her drop keel raised, and her sails, spars and rigging hauled clear. Her mast should then be unshipped and lashed to the sails and spars, and be allowed to float clear of the boat but secured to her by a line.

If the boat is floating bottom upwards it may be possible to right her by securing two or more lines to one of the bilge rails and reeving them right round the boat; then, by hauling on the lines with the feet braced against the side of the boat, it may be possible to parbuckle her the right way up.

Whenever possible, a swamped sailing boat should be unrigged and the mast unshipped before she is taken in tow.

Effect and Use of Drop Keel

The chief effect of a drop keel is to reduce the leeway made by a boat when beating or reaching, but it also has other effects which are not commonly realised. In a small boat such as a dinghy the keel may weigh nearly as much as the hull, and when lowered it lowers the centre of gravity of the boat and thus has a stabilising effect, but in larger boats the keel is light in comparison with the hull and the stabilising effect of its weight is therefore negligible.

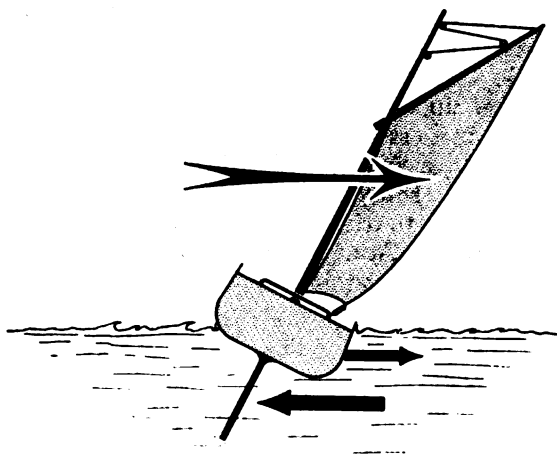


Fig. 194. Capsizing effect of a drop keel in a squall

When the keel is lowered the resistance offered by the water to its surface resists any tendency of the boat to roll, but when the boat is under sail and making leeway this lateral resistance will produce a capsizing moment, as illustrated in Fig. 194. This moment is not appreciable under normal conditions of beating and reaching, but may become dangerous if the boat is blown broadside to leeward by a sudden squall, or if she yaws badly or broaches to when running.

The extent to which the keel should be lowered under the various conditions of sailing depends largely upon the type of the boat and can be found only by experience, but as a general guide it can be said that it should be fully lowered when beating, lowered half way when reaching, and fully raised when running. The drop keel should, of course, always be raised if there is any chance of the boat grounding, because if it hits the bottom not only might it be bent and so

prevent its being raised, but it might also either capsize the boat or split her open.

The amount of leeway a boat will make depends upon her length and draft, the windage of her hull and sails, the course she is steering, the strength and direction of the wind, and the state of the sea. In favourable circumstances a Service boat sailing on a wind should be able to make good a course about 6 points (67°) from the wind.

Getting Under Way and Coming Alongside

Before getting under way consider the weather conditions. If it is blowing hard take a full crew and extra water barricoes as ballast, and do not hesitate to take down one or more reefs before making sail. When under way it is much easier to shake out a reef than to take one down.

Before leaving the boom or ladder see that the sails are on the outboard side of the boat, the sheets are rove correctly, and the halyards and brails or topping lifts clear for running.

To get under way spring the boat ahead, and cast her on the required tack, if necessary by backing the foresail to windward or bearing out the mizzen boom to leeward; from a ladder the boat is sprung ahead on the boat-rope, and from the boom by passing the lizard aft and hauling on it. Then hoist the foresail, and as it draws set the mainsail and sheet it home. Trim the boat and the sails, and see that all is shipshape (fenders in, no rope's ends outboard, running rigging coiled down or in hand, and the crew in the bottom of the boat).

Always go alongside head to wind if possible. Approach the ladder (or landing place) on a reach and steer for the ladder or just ahead of it. Remember that a heavily laden boat will fore-reach (i.e. carry her way) much farther than a lightly laden one. Give the order "Down foresail" in plenty of time for the bowman to get out his boat-hook and fend off the bows, and, at the same time, order the fenders out. Haul aft the mainsheet as you ease the helm down and brail up just before the boat reaches the ladder; if the boat is likely to overshoot the ladder the sternsheetsman should be ready to check her with the checkline thrown from the lower ladder platform. An experienced coxswain should be able to bring his boat to rest with her stern sheets exactly alongside the gangway ladder without bumping it, or having to check her way with the check-line, by putting the helm hard down at exactly the right moment; putting the helm hard over acts as a powerful brake in taking all way off the boat and preventing her from fore-reaching.

If it is not possible to go alongside head to wind have a drogue ready to check the way of the boat, and approach under shortened sail. A drogue can be fashioned from a bucket on a stout line streamed over the stern and belayed to the stroke thwart. Sail can be shortened by checking the sheets and spilling some of the wind from the sails, or settling the main halyard, or brailing up the mainsail and running in on the foresail; the latter is the most effective and must always be done with a following wind. In gaff-mainsail boats sail can be shortened by settling the peak halyard, thus "scandalising the mainsail", but in a strong wind and with a heavily laden boat it is best to lower the sails and proceed alongside under oars.

Man Overboard

If a man falls overboard from a boat under sail, at once throw out a life-jacket, oar, grating, or anything else which may help him to keep afloat; then

detail one of your crew to keep his eyes on the man, and get boat-hooks and lines ready for grappling him.

If you are beating, or on a reach, wear your boat round so as to bring her to leeward of the man, whence you can approach him close-hauled and then luff up alongside him (see Fig. 195) ; your crew will then be able to get hold of him while the boat is stopped or only moving slowly, and he will not be dragged out of their hands.

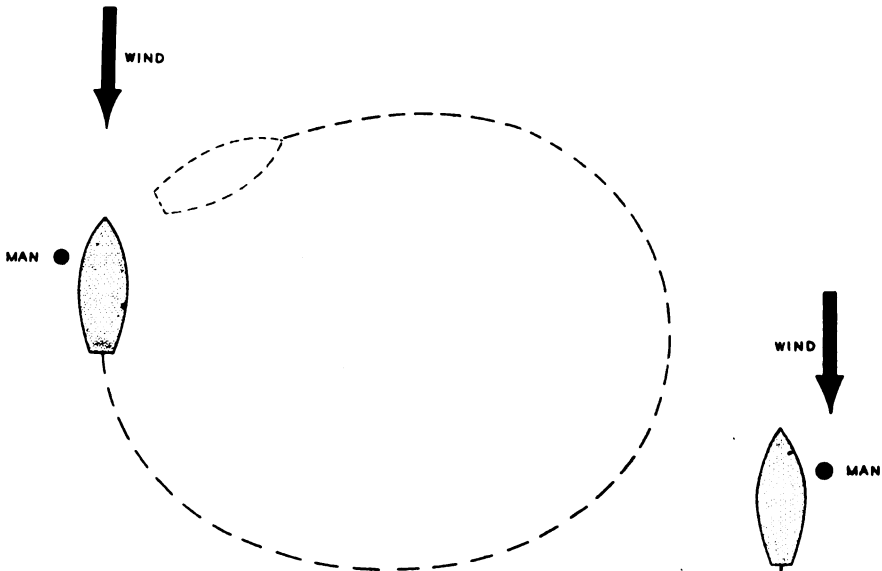


Fig. 195. Man overboard when beating or reaching

If you are running you must run on for a short distance, then bring your boat round close-hauled on the same tack, and then go about so that you will come up just to leeward of the man and so be able to luff up alongside him (see Fig. 196).

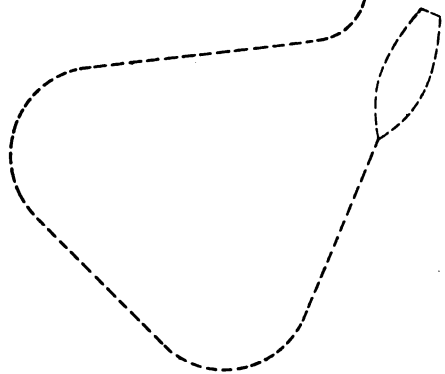


Fig. 196. Man overboard when running

Heaving To

A boat is hove to in order to keep her as nearly stationary as possible ; this is done by backing the foresail, sheeting aft the mainsail or mizzen, putting the helm down and adjusting the trim of the sails. The direction in relation to the wind in which a boat will best remain hove to depends largely upon her free-board and the sails she can set. A whaler will lie comfortably hove to beam on to the wind under her foresail and mizzen only. A cutter is difficult to heave to because of the different areas of her foresail and mainsail and their consequent turning effect on the boat about her pivoting point; she lies best when hove to

under her foresail and storm trysail, with the boat trimmed as necessary to balance her against the wind.

Riding to a Sea Anchor

If a boat is overtaken by a gale when she has plenty of room to leeward it is safest to lower her masts and sails and let her drift with the wind and sea, provided of course that she is not being blown out to sea or too far from her destination. If she has little sea room, however, it is best to ride out the gale to a sea anchor. The sea anchor provided in the Service, which is also used as the boat's drogue, is a cone-shaped bag of canvas, open at both ends and with one end much larger than the other, which is designed to be secured by its large end to the boat's cable. When thus secured it is streamed over the bows, the cable is paid out to a clench, and the boat then rides to the drogue with her head to wind and sea as she drags it slowly through the water. In a strong gale, she will thus drift astern at a speed of about $1\frac{1}{2}$ knots.

The following is a useful formula for determining the dimensions of a drogue for any particular boat :

for the diameter of the mouth allow one inch for every foot length of the boat at her waterline ;

the length of the drogue should be one and a half times the diameter of its mouth ;

the diameter of the tail should be about one-eighth the diameter of the mouth.

A drogue suitable for a 32-ft. cutter is shown in Fig. 197. It is fitted with a four-legged bridle and the mouth is held open by an iron hoop. The weight of the hoop should sink the drogue so that it tows below the surface of the water.

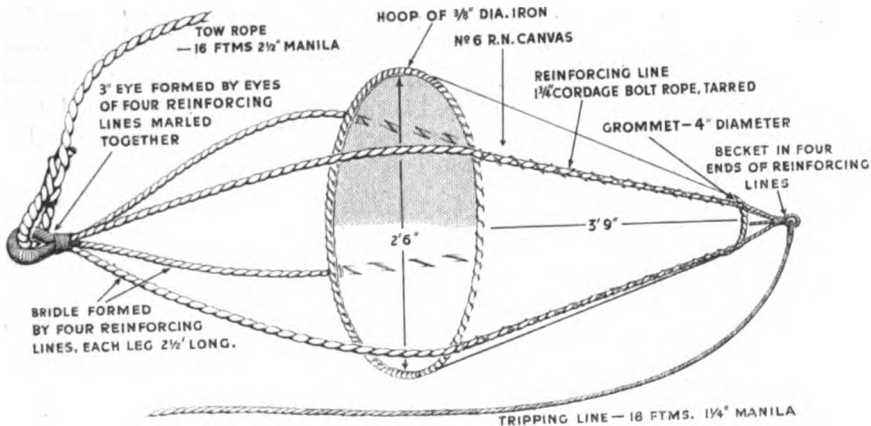


Fig. 197. A sea anchor or drogue

The boat's cable is bent to the ring of the bridle and the drogue is then streamed ahead so that the boat rides head on to the drogue at the full scope of her cable. If the boat yaws badly this can be checked by rigging the mizzen and sheeting it home. In a cutter it should be possible to rig a jury mizzen on an oar. When no longer required the drogue is tripped by its tripping line and hauled in tail first.

If a proper drogue is not available an extempore one can be rigged from a foresail with a three-legged bridle bent to its corners ; a hole about 4 inches in diameter must be cut in the centre of the sail, and one corner must be weighted so that it tows upright. If no sails or awnings are carried a sea anchor can be made by securely lashing together oars, stretchers, gratings and other such fittings, and then securing them by a two-legged bridle to the boat's cable so that she will drag them broadside on through the water.

The waves can be prevented from breaking heavily by oil dripped over the bows in small quantities from a large can or drum ; any oil will do, but animal or vegetable oils are the most effective. The amount required is not great ; oil dripped at a rate of between one and two pints an hour should be sufficient appreciably to calm the sea to windward.

BOATS' SAILS

Care of Boats' Sails

Boats' sails must always be carefully handled and properly maintained, otherwise they will not set correctly and so will lose their effectiveness. The bending and stretching of new sails is particularly important, as it is possible to ruin a new sail by wrong treatment. A sail is cut and sewn to exact measurements which allow for the initial stretch of the sail, and it is most important to ensure that this initial stretch is uniform and not excessive.

After a sail has taken up its initial stretch it is not very elastic and so can be permanently distorted by undue stretching ; if the sail becomes wet its clew or peak earrings, and the lacing to the boom, gaff, or yard, should therefore be eased away, and the halyards be settled to ease the strain on its luff and leach.

When not in use sails should be folded carefully and stowed in their covers, but no sail should be stowed when wet ; if wet from salt water it should be rinsed in fresh water and then dried before being stowed. Dirty sails should be washed in fresh water with soap and, if necessary, very lightly scrubbed, but the bolt-rope should not be scrubbed because this takes a lot of the tar out of it and weakens it. When triced up to dry, sails should be stopped in place and not allowed to flap about.

The best method of stretching new sails is to sail with them on a sunny day in a light breeze, but the following precautions must be observed :—

- do not set up the halyards or tack tackle too taut, otherwise the luff may be stretched more than the leach ;

- do not haul the sheets flat aft, because this may distort the clew ; constantly take up any slack in the head and foot with the peak and clew earrings ;

- keep the sails dry and do not reef them until they are fully stretched, and, if a sail should get wet, settle the halyard and ease away the peak and clew earrings.

Metal fittings should not be stowed with the sails. Preferably sails should be unbent from their spars for stowage, but if this is impracticable the peak and clew earrings and the lacings should be eased away before stowing. To make up a sail on a yard lay the luff and the leach along the yard and gather up the bight underneath ; the last of the bight should then be rolled up and the stops passed.

To Bend a Sail to a Spar

The head of a mainsail is bent to a yard or a gaff by throat and peak earrings and a lacing; the throat earring is the fixed anchorage and the peak the movable one.

The foot of a mainsail or a trysail may be bent to a boom by tack and clew earrings and also be laced to the boom; the tack earring is the fixed anchorage and the clew the movable one.

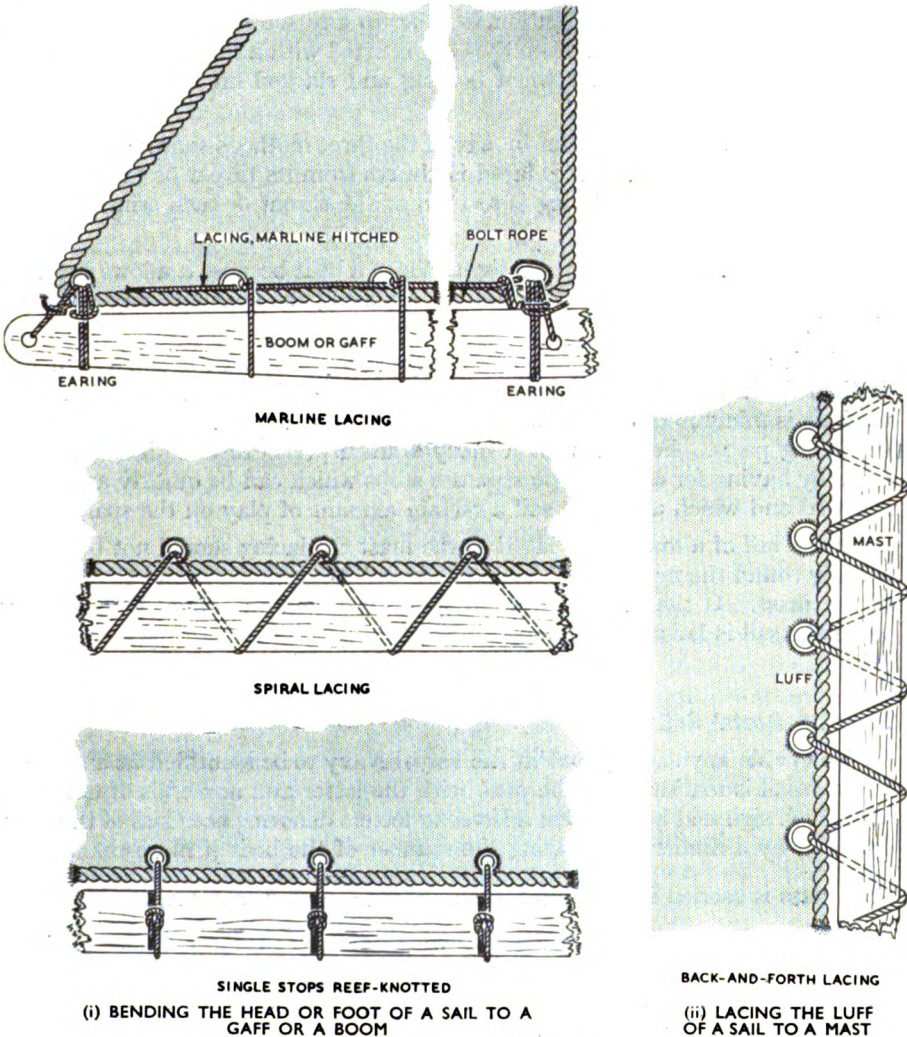


Fig. 198. Bending a sail to a spar

The earring has an eye spliced in one end and is secured to the sail by passing the other end through the cringle at the throat, peak, tack or clew, and back through its own eye. To pass a throat or tack earring lay the bolt-rope next to the spar and reeve the earring through the hole or eyebolt in the spar and back through the cringle, and haul it taut; then take two or three turns round the spar and through the cringle and finish off with a clove hitch round all parts

between the spar and the bolt-rope. To pass a clew or peak earring reeve the earring through both the hole or eyebolt in the spar and through the cringle, and haul out the foot or head of the sail hand taut ; then take two or three turns round the spar and through the cringle, and finish with a clove hitch round all parts. The head or foot of a sail should not be hauled out too tautly along a spar, because then it would be unable to take up its natural belly and thus be pulled out of shape ; there should be about one inch clearance between the bolt-rope and the middle of the spar. When stretching new sails the peak and clew earrings require constant attention to take up any slack in the head or foot. In some mainsails bent to a boom the clew is fitted with a small tackle by which the foot can be hauled taut when beating and slacked off when reaching or running.

A sail may be laced to a spar by any of the three methods shown in Fig. 198 ; but the direction in which it is laced is always from its throat or tack towards its peak or clew, and the lacing is secured to the throat or tack cringles in the same way as is the earring.

The spiral lacing is best for the light sails of a boat because it allows the head or foot of the sail to take up its natural set along the spar and any resultant chafe is negligible.

The heavier sails of larger vessels may be marled to their spars. In this method the head or foot of the sail is firmly secured to its spar and any tendency to chafe is minimised, but the whole lacing will probably have to be renewed if the lacing parts. For this reason many seamen prefer to bend heavy sails to spars by having for each cringle separate stops which can be quickly and easily renewed and which allow the sail a certain amount of play on the spar.

If the luff of a mainsail is laced to the mast the lacing should not be passed spirally round the mast, but " back and from " the cringles round the fore side of the mast. If the lacing is passed spirally, or marline hitched, it will jam when the sail is hoisted or lowered.

Marking Boats' Sails

To enable any sailing boat in the Royal Navy to be identified at a distance its mainsail is marked near the peak with the letter and numerals of the ship's visual call sign and below them a letter or letters denoting the class of the boat, followed by a numeral indicating the number of the boat if more than one of that class is carried in the ship ; the marking $\frac{B02}{RN3}$ for example, would identify the third 14-ft. dinghy of a battleship whose visual call sign is B02. (The distinguishing letters for each class of sailing boat are given in the table " Particulars of Pulling and Sailing Boats " on pages 348 and 349).

The distinguishing marks are painted on calico or light canvas, which is sewn to each side of the peak of the mainsail on a line parallel with the gunwale of the boat. The depths of the letters and numbers for the three main classes of boats should be :—

	ft.	in.
for cutters	1	9
for whalers	1	6
for dinghies	1	0

Measurement of Boats' Sails (Fig. 199)

The standard method of measuring the area of a boat's sail is described below.

All measurements are taken from the corner at which the edges of two sides meet to the edge of the opposite side, the edge being the edge of the selvage. The sail should be measured at full stretch.

A four-sided sail is divided into four areas as follows :—

Join the peak to the clew by a straight line and drop two perpendiculars to it from the throat and the tack, thus forming the triangle $A G B$ and the trapezoid $G F C B$; the area of the triangle will then be $\frac{1}{2} G B \times A X$, and that of the trapezoid will be $X Y \times \frac{(G B + F C)}{2}$. Now join the tack to the

clew, thus forming the triangles $F E C$ and $E D C$; the area of the former will then be $\frac{1}{2} F C \times Y E$, and that of the latter $\frac{1}{2} E C \times D Z$ (the perpendicular $D Z$ is dropped at the greatest depth of the foot). The area of the whole sail is the sum of its four component areas.

A three-sided sail is divided into three areas as follows :—

Join the head to the tack by a straight line and to it drop a perpendicular from the clew, thus forming the triangle $H K L$ whose area will be $\frac{1}{2} K L \times H M$. Now join the tack to the clew by a straight line, thus forming the triangles $L K J$ and $K P J$; the area of the former will then be $\frac{1}{2} K L \times M J$, and that of the latter $\frac{1}{2} K J \times N P$ (the perpendicular $N P$ is dropped at the greatest depth of the foot). The area of the whole sail is the sum of its three component areas.

POWER BOATS**Handling of Power Boats generally ***

Handling a power boat is very different from handling a pulling or sailing boat, because the rotary movement of her propeller (or propellers) exerts a considerable effect on the directive powers of her rudder, not only when she is moving through the water but also when she is stopped or has lost steerage way. The extent to which the steering of a boat is affected by the movement of her propellers depends upon their number and size, the direction in which they revolve, the speed of their revolution and the shape of the boat's hull.

The direction of rotation of a propeller is described as being either right-handed or left-handed; a right-handed propeller is one that turns in a clockwise direction when driving the boat ahead and viewed from astern, and a left-handed propeller is one that turns in an anti-clockwise direction under the same conditions. Most single-screw boats or vessels have right-handed propellers and most twin-screw boats or vessels have out-turning propellers (right-handed on the starboard and left-handed on the port side), but in some such Service boats both propellers turn the same way.

The handling of any type of power boat is governed in general by the common sense rules of seamanship, but the method of manoeuvring one boat may differ considerably from that of manoeuvring another, owing to differences in the shape of their hulls, the number of their propellers and the type of their rudders. In describing here how different types of power boat are handled and manoeuvred they are divided into three main categories, namely :—

* See also "Hints to Coxswains of Boats", pages 245 to 249; "Notes on the Handling of Boats' Engines", pages 313 to 317; and "Towing Pulling Boats", page 317.

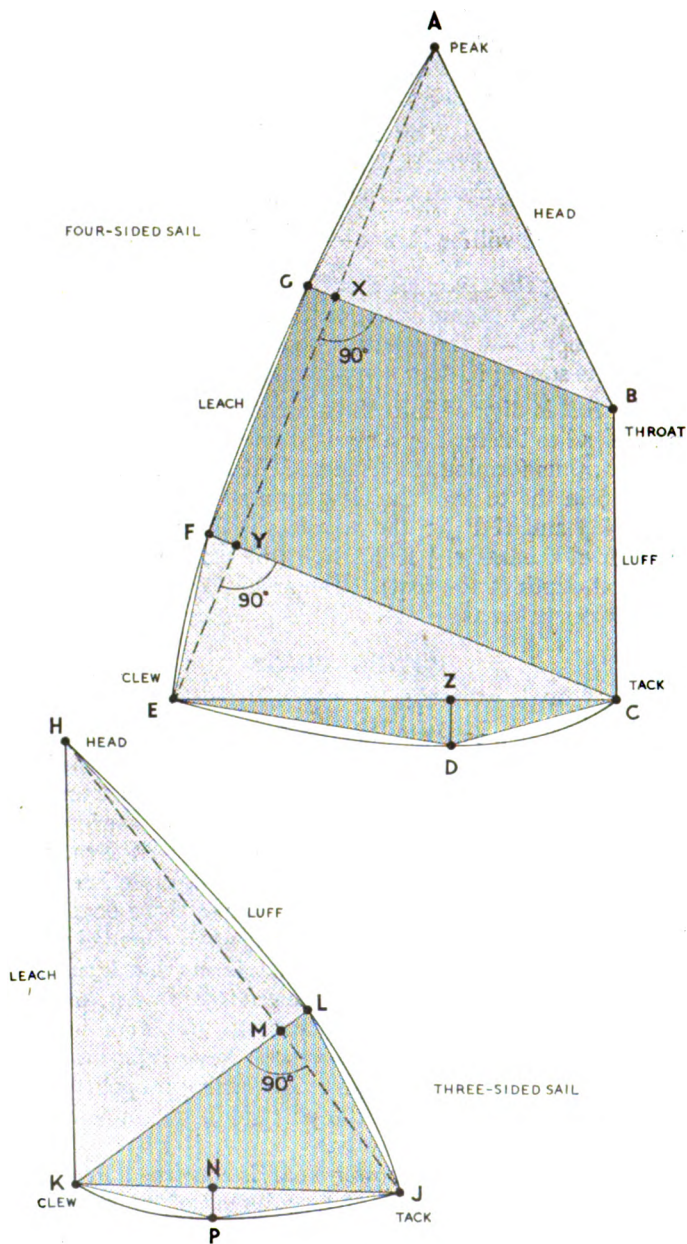


Fig. 199. Method of measuring boats' sails

- (i) all types of power boat ;
- (ii) round-bilge power boats ; and
- (iii) hard-chine power boats.

The two last categories are necessarily sub-divided into single-screw boats, twin-screw and triple-screw boats, and boats fitted with the " Kitchen " rudder.

Use of the Rudder. The turning effect of the rudder when the boat is under way increases with an increase in the speed of the boat as well as with an increase in the angle between the rudder and the fore-and-aft line of the boat, and it reaches its maximum value when the latter is about 35°. Beyond 35° the turning effect begins to decrease and the retarding effect of the rudder on the speed of the boat increases rapidly. The rudder angle of a boat is therefore limited to 35° each way.

When the boat turns under the effect of her rudder she turns about a pivoting point which is usually at about one-third of her length from the bows in round-bilge boats, and further forward or aft in hard-chine boats. This pivoting point should be borne in mind when leaving an accommodation ladder or landing place, because if the rudder is put over to swing the bows outwards the stern may swing in towards the ladder or landing place and so damage the boat or the ladder.

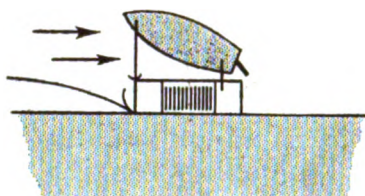
When turning at speed, particularly if the rudder is put hard over, the boat will skid over the water broadside on and outwards as she turns before gathering way in the direction in which her bows are pointing ; this is more marked in a shallow-draught or a hard-chine boat than in a deep-draught or a round-bilge boat. As the boat skids the resistance of the water to the hull will heel the boat outwards, and the degree of heel will depend upon the type of boat, her speed and her loading ; it will be more marked in a round-bilge than in a hard-chine boat, and in a boat laden with top-weight than in a normally loaded boat. *The rudder should therefore never be used drastically, particularly in boats laden with men or gear, or in a heavy sea, on which occasions the speed of the boat should be reduced when altering course.*

When proceeding at full speed a boat is very sensitive to even a slight touch of wheel, so a large amount of rudder should then only be used in emergency. Except in emergency or at low speed, drastic use of the rudder shows lack of foresight or judgment, and is therefore bad seamanship.

When proceeding slowly, however, or when manoeuvring your boat in a confined space, it will often be necessary to use full wheel, *i.e.* to put the rudder hard over.

The trim of a boat has a great effect on her steering ; if she is down by the head or the stern she will be difficult to manoeuvre, and men or weights should therefore be kept distributed evenly amidships as far as possible.

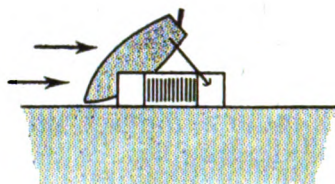
Handling in a Seaway. When running before a sea, or when towing, the boat should be trimmed by the stern to keep her propeller immersed and improve her steering qualities. When running before a swell which appears to be moving at the same speed as the boat reduce speed immediately, if necessary by streaming a drogue ; otherwise your boat may be carried along on the front of a wave and may broach to and capsize. When running before a quartering sea or swell be on your guard against a wave bearing under the weather counter and so broaching the boat to. When sea or swell are on the bow meet the larger waves head on, and reduce speed as necessary. Alteration of speed in a seaway will have a great effect on the behaviour of the boat so adjust your speed to suit the state of the sea.



1

1. The bowman has failed to secure the boat-rope ; the bows have swung out, the stream is bearing on the inner bow and the sternsheetsman is gripping the stern in to the ladder.

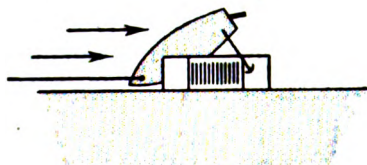
Remedy : Let go forward and aft, then go ahead and come alongside again.



2

2. The boat has overshot the ladder and the bowman has gripped in the bows. The stream is bearing on the outer bow and forcing the boat under the ladder, while the sternsheetsman is attempting the impossible in trying to haul the stern in towards the ladder.

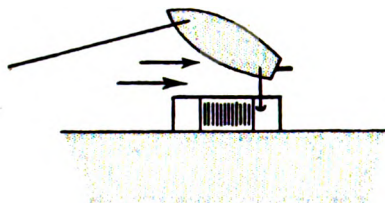
Remedy : Let go aft, go full speed astern and come alongside again.



3

3. The bowman has secured the boat-rope correctly over the inner bow, but the coxswain has forgotten to use his rudder and has allowed the bows to swing in to the ship's side. Meanwhile, the sternsheetsman is attempting the impossible in trying to haul the stern in towards the ladder.

Remedy : Put on starboard rudder, so that the bows will swing out and the stern swing in ; then steer the boat so that she rides alongside the ladder.



4

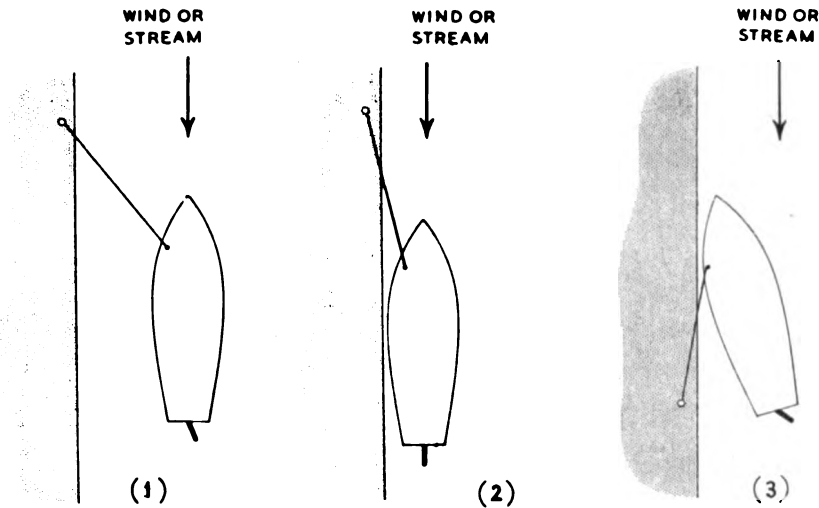
4. The bowman has secured the boat-rope correctly over the inner bow, but the coxswain has forgotten to use his rudder and has allowed the bows to swing out. Meanwhile, the sternsheetsman is gripping the stern in to the ladder.

Remedy : Let go aft and put on port rudder until the boat rides head to stream clear of the ladder ; then steer her gently in until she lies alongside correctly.

Fig. 200. Faults in handling a boat alongside in a tideway

Speed. When under way in harbour proceed with due consideration for others. The wash made by a boat at high speed can do considerable damage, so reduce speed, or give a wide berth when passing them to small boats, ship's ladders, or ships being painted, etc., and keep a good look out for divers at work.

Going alongside and casting off. When going alongside an accommodation ladder in a tideway avoid overshooting and getting the stream on your outer bow, otherwise your boat may be jammed by the stream under the forward side of the ladder and may even be heeled over and swamped. When lying alongside a ladder in a tideway secure the boat-rope over the inner bow, and steer the boat so that she rides by the boat-rope with her side a foot or so clear of the ladder (see Fig. 200). When casting off from an inner billet at the lower boom in a tideway drop astern to clear the outer boats ; if you try instead to pass ahead of them the stream may set your boat athwart their bows, in which position she will probably be heeled over by the stream and swamped.



1. To get the boat alongside from the position in Fig. 1, make fast the head-rope on the jetty ahead of the boat ; then put on starboard rudder and either go "slow astern" or allow the wind to drop your boat alongside, as shown in Fig. 2. The head-rope is used here as a spring.

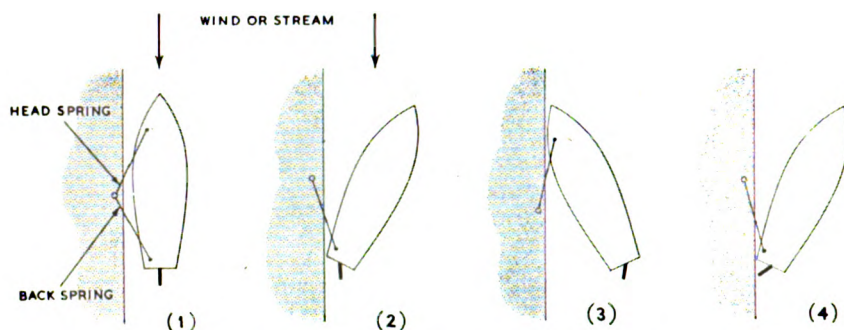
2. To get the boat alongside from the position in Fig. 3, lead the head spring aft from abreast the pivoting point of the boat, and make it fast on the jetty. Then put on starboard rudder and go "slow ahead" on the head spring so that the stern will come in.

Fig. 201. Use of springs when going alongside

When approaching a landing place take into account the direction and strength of the wind and tidal stream, and whenever possible go alongside head to wind or stream, whichever has the most effect on your boat ; a 1-knot stream is about equivalent to a wind of force 3 to 4, and a 2-knot stream to a wind of force 5 to 6. If the landing place lies across wind or stream and there is a choice of sides choose the lee side. Always approach a ladder or landing place at slow speed and keep the boat heading in a safe direction in case her engines fail to go astern. When lying alongside, particularly when head to wind or stream, secure your head and stern ropes as springs ; they will be more effective in holding your boat alongside when thus secured than when secured as breasts or led ahead and astern of the boat. If manoeuvring space near the landing place is limited it is better to leave it bows first than stern first, particularly in a single-screw boat. When leaving a landing place always bear the boat well off before using your engines ; if the boat is too heavy to bear off, cast her off on her springs with the help of the wind or stream, or your engines (see Fig. 202). When going alongside a strange landing place in shallow water approach cautiously and take soundings over the bows with a boathook.

Shoal water. A boat running into shoal water at speed will settle deeper in the water and trim by the stern ; at the same time her hull wash will increase, a stern wave will build up, and the hull will vibrate. If these signs become evident stop immediately and back astern into deep water on the opposite course. Avoid taking a boat into shallow, muddy, or sandy water, because the mud or sand will be churned up and may choke the cooling system of the engines.

Towing. When towing a pulling boat it is usual to use her painter as the tow-rope, bringing it to your lee quarter cleat with one turn round the stem of the cleat and half a turn round its after horn, the end being tended by the stern-sheetsman so that the tow can be slipped at a moment's notice ; on no account should a hitch be made or the end left untended. When towing more than one boat the heaviest should be first in the line of tow and the lightest last. Boats



1. Boat secured alongside with her head and back springs, head to wind or stream.
2. To go ahead from alongside, put on starboard rudder and cast off the head spring so that the bows will pay off from jetty under the influence of the wind or stream. When the bows have swung out far enough, put the rudder amidships, go "slow ahead" and cast off the back spring.
3. To go astern from alongside with no wind or stream to help, cast off the back spring, put the rudder to port, go "slow astern" on the engines against the head spring; this will gripe the bows in so that the stern will swing out from the jetty. When the stern has swung out far enough, put the rudder to starboard, go "slow astern" and cast off the head spring.
4. To go ahead from alongside with no wind or stream to help, cast off the head spring, put the rudder to port, and go "slow astern" against the back spring; this will gripe the stern in, and the bows will pay off from the jetty. When the bows have paid off far enough, put the rudder amidships, go "slow ahead" and cast off the back spring.

Fig. 202. Use of springs when casting off

may be towed in calm water at fairly short stay, but in a lop or heavy sea the length of the tow should be increased so that both boats ride comfortably. The total weight of the tow should not, in normal circumstances, exceed the weight of the towing boat, otherwise an unfair strain will be put on her engines.

To tow a heavy vessel make her tow-rope fast as near to the pivoting point of your boat as possible; this may necessitate removing your after canopy. If the tow-rope is made fast to your quarter cleat the weight of the tow will gird the stern of your boat so that she will not answer her helm readily.

If the tow yaws badly pass another tow-rope from one quarter of your boat to the opposite bow of the tow (see Fig. 203 (i)), and equalise the strain on both ropes. Another method is to tow the vessel on a bridle, one leg of which is shorter than the other (see Fig. 203 (ii)).

To tow a lighter alongside secure your boat to her quarter, as shown in Fig. 203 (iii). With the boat secured thus your rudder and propeller will not be blanketed by the lighter's wash, and your rudder will exert a far better turning moment about the combined pivoting point of the two craft than it would if your boat were made fast to the lighter amidships.

Engine-order Code. In boats not fitted with engine-order telegraphs orders for the engines are given by blasts on a mouth-whistle or on a gong in accordance with the following code :—

Order	Meaning
One blast or stroke ...	Stop. (In steam boats and boats fitted with a Kitchen rudder the engine is stopped, but in other boats the engine is declutched and throttled down to idling speed.)
Two blasts or strokes ...	Normal full speed ahead.
Three blasts or strokes ..	Normal full speed astern.
Four blasts or strokes ... (two pause two)	Slow speed ahead. (In boats fitted with a Kitchen rudder the engine is throttled down to idling speed.)

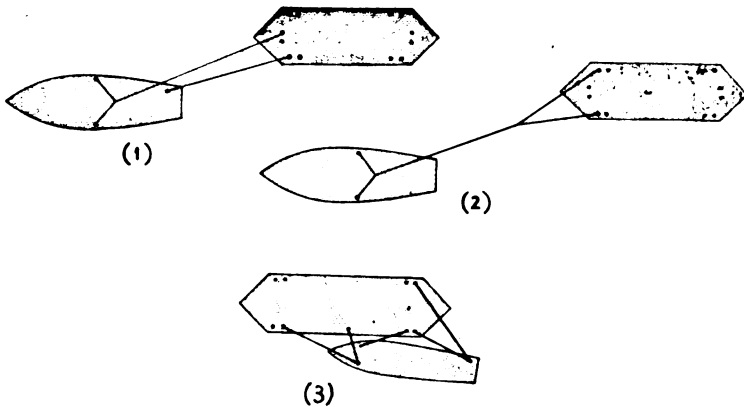


Fig. 203. Methods of towing

Handling Round-bilge Boats

SINGLE-SCREW ROUND-BILGE BOATS

A revolving propeller will exert a sideways thrust on the after part of the hull, and the extent of this thrust and its effect on the boat depend upon :—

- (i) whether the boat is at rest or moving ;
- (ii) whether she is moving ahead or astern ;
- (iii) the speed at which she is moving ; and
- (iv) the rate at which the propeller is turning.

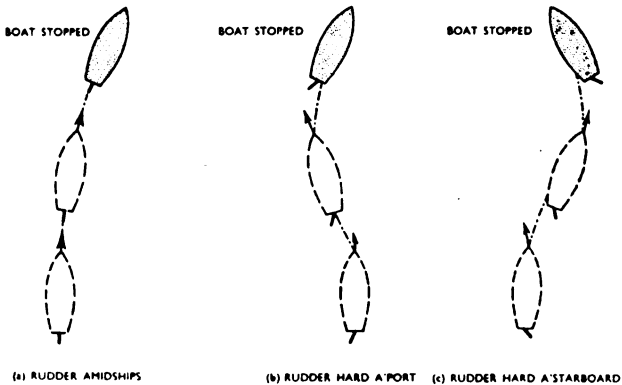
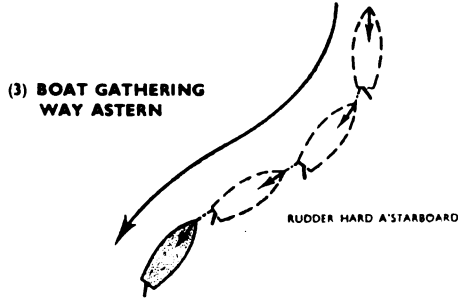
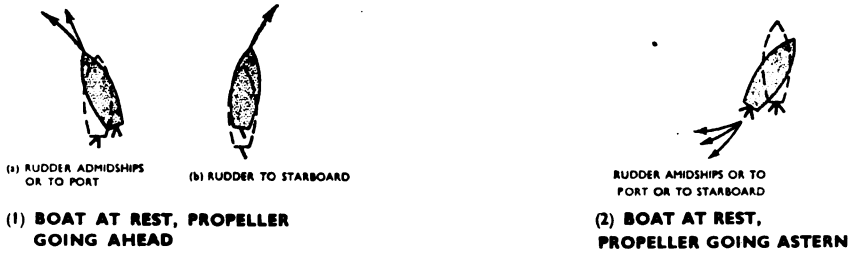
It is not necessary for the helmsman to understand the theory underlying the effects of a revolving propeller, but he should know what effects it has on the steering of his boat under various circumstances. The most important of these effects in a boat with a single, right-handed propeller are described here and it should be borne in mind that the faster the propeller is revolving and the slower the boat is moving the greater will be these effects.

Boat at Rest, Propeller Going Ahead (Fig. 204 (1)). If the rudder is a'midships or to port the stern will kick to starboard, but if the rudder is to starboard the kick will be counteracted.

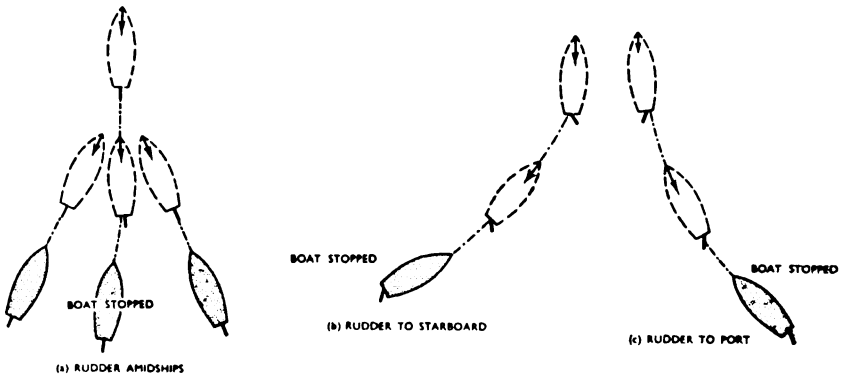
Boat Gathering Headway. As the boat gathers headway the side thrust of the propeller diminishes, and it becomes imperceptible as soon as the boat gets steerage way.

Boat at Rest, Propeller Going Astern (Fig. 204 (2)). The stern will kick to port whatever the position of the rudder, but the kick will be more pronounced if the rudder is to port.

Boat Gathering Sternway (Fig. 204 (3)). As the boat gathers sternway the stern will continue to swing to port to a greater or lesser degree, according to the setting of the rudder, but as the speed of the boat increases so the turning effect of the rudder increases, and with starboard rudder on the swing will be reduced and, in some boats, may be checked completely. Very few right-handed, single-screw boats, however, can be made to swing stern to starboard when going astern, even with the engine at full speed, but if the propeller is stopped when the boat has good sternway on her the rudder will exert its full effect.



(4) ENGINES REVERSED TO FULL SPEED ASTERN WHEN BOAT IS GOING FULL SPEED AHEAD.



(5) ENGINES PUT TO FULL SPEED AHEAD WHEN BOAT IS GOING FULL SPEED ASTERN

Fig. 204. Rudder and propeller effects in a right-handed single-screw boat

When, therefore, a right-handed, single-screw vessel is turned about in a narrow fairway by going alternately ahead and astern, she turns to starboard when going ahead, and to port when going astern, in the manner described below (see Fig. 205) :

First put the rudder to starboard and go ahead ; the stern will immediately kick to port and will swing off more rapidly as she gathers way. Allow her to forge ahead as far as space admits, then reverse the engine and put the rudder hard-a-port ; this will keep the stern swinging to port. Let the boat gather as much sternway as space admits, then go ahead and put the rudder hard-a-starboard ; it is at this point that the most pronounced turning effect will take place. Continue this procedure as necessary.

If more convenient to go astern first, begin by going astern with the rudder hard-a-port ; if there is a breeze on the starboard side avoid going astern too far, or the boat will back into the wind. If the breeze is on the port side it will be advantageous to go astern as far and as fast as space permits.

If the space is sufficient to admit of going ahead and astern for some distance and at fair speed it will not be difficult to turn to port, but the turn to starboard will always be more easily and rapidly made.

Boat Going Ahead, Propeller Going Astern (Fig. 204 (4)). This is in some respects the most important case because it occurs in emergency or when going alongside. As soon as the propeller starts to revolve the boat will fail to obey her rudder in the normal manner and her behaviour will depend upon the setting of her rudder.

In the following examples it is assumed that the engine is suddenly reversed to full speed astern when the boat is going full speed ahead, but the slower the boat is going ahead and the faster the propeller is revolving the more marked will be her behaviour.

- (i) *Rudder a' midships* (Fig. 204 (4a)). The boat's head will fall off to starboard, and the boat will gain ground to starboard before losing her way.
- (ii) *Rudder hard-a-port* (Fig. 204 (4b)). The boat's head will usually go to port at first, but not very rapidly or very far ; it will then begin to swing to starboard.
- (iii) *Rudder hard-a-starboard* (Fig. 204 (4c)). The boat's head will first pay off to starboard, but usually will soon steady up and swing slowly back to port and the boat will come to rest with her head a point or two to

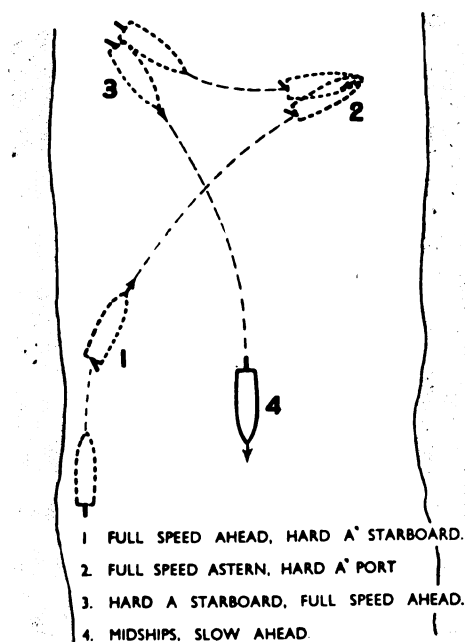


Fig. 205. Turning in a narrow fairway in a right-handed single-screw boat

port of her original course. In some boats, however, the boat's head will first kick to starboard and then swing slowly in that direction.

Because of these peculiarities a right-handed, single-screw boat will usually be put alongside with her port side to, for the following reasons (see Fig. 206) :—

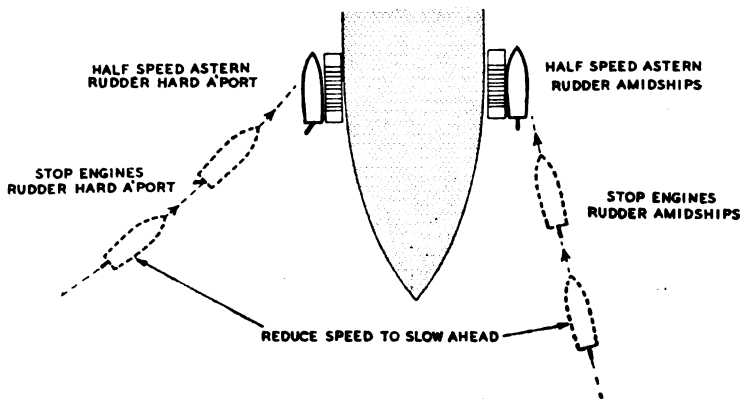


Fig. 206. Going alongside, starboard or port side to, in a right-handed single-screw boat

When going alongside port side to, the boat can approach on a steady course at a small angle to the ladder, and when her engine is put astern to reduce her way the action of the propeller will kick her stern in towards the ladder so that she will bring up squarely abreast it.

When going alongside starboard side to, the boat must make her final approach at a broad angle and with her head swinging to port, so that when her engine is reversed to reduce her way the swing of her stern to starboard will counteract the kick of her propeller to port and so allow her stern to swing in towards the ladder. This is a more difficult manoeuvre than the other and requires better judgment.

Boat Going Astern, Propeller Going Ahead (Fig. 204 (5)). Here again the behaviour of the boat will depend upon the setting of her rudder, her speed, and the rate of revolution of her propeller.

If the engine is put to full speed ahead when the boat is going full speed astern the boat will re-act in the following manner :—

- (i) *When the rudder is a'midships* (Fig. 204 (5a)) no definite forecast of the boat's behaviour can be given because in this case so much depends upon the type of boat. The boat's head may remain steady, or pay off slightly to port or starboard.
- (ii) *When the rudder is to starboard* (Fig. 204 (5b)) the boat's head will pay off to starboard.
- (iii) *When the rudder is to port* (Fig. 204 (5c)) the boat's head will pay off to port.

HANDLING TWIN-SCREW ROUND-BILGE BOATS

Manœuvring a twin-screw, round-bilge boat is much easier than manœuvring a similar single-screw boat, especially if she has out-turning propellers. When both propellers are going ahead or astern at the same rate the sideways thrust of one cancels that of the other, and the boat will answer her rudder in the normal manner provided that she has steerage way.

The boat can be turned at rest on her heel with her rudder a'midships by going ahead with one propeller and astern with the other, and by adjusting their rates of revolution so that the boat does not gather way either ahead or astern. But, if manoeuvring space allows, the boat can be turned more quickly if she is given a little headway or sternway with the rudder set in the direction of turn. Some boats turn better when going ahead and some when going astern. If there is a wind blowing some turn better if manoeuvred head to wind and some stern to wind. Each boat has its own peculiarities so no hard and fast rules can be laid down, but it should be borne in mind that when the boat is at rest, or moving slowly ahead or astern, she will answer to the thrust of her propellers rather than the settings of her rudder.

HANDLING A SINGLE-SCREW, ROUND-BILGE BOAT FITTED WITH A "KITCHEN" RUDDER

Single-screw, round-bilge boats fitted with a "Kitchen" rudder are the most manoeuvrable of all single-screw boats, and possess a greater degree of manoeuvrability than many twin-screw boats.

The rudder consists of two curved metal plates mounted so that they encircle the propeller (see Fig. 207). The movement of the tiller to port or starboard will turn both plates to starboard or port, respectively, in the same manner as an ordinary rudder. In addition, the plates can be closed together abaft the propeller, or opened out on each side of it, by a shaft which revolves inside the rudder post and is controlled by a wheel and worm gearing on the tiller.

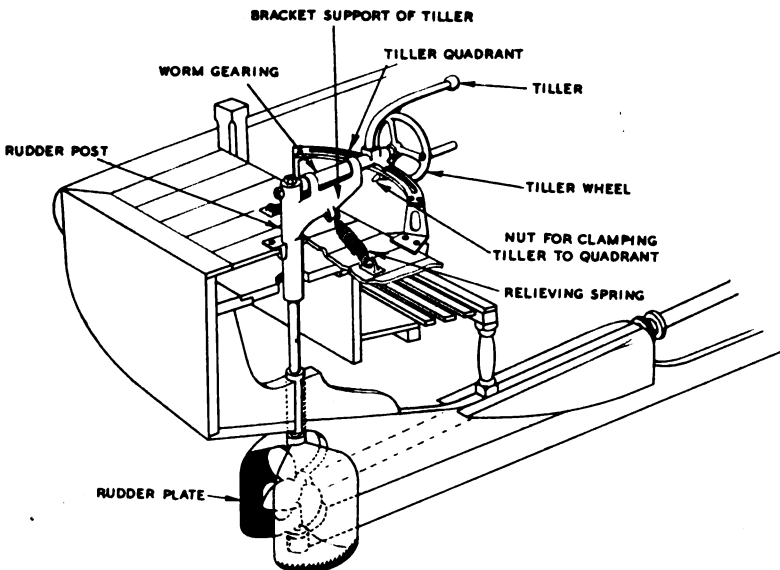


Fig. 207. The Kitchen rudder

A "relieving spring" is fitted to each side of the tiller just before the rudder post to prevent the rudder from swinging from side to side and taking charge in a seaway. The fore end of the tiller is supported by a quadrant to which it can be clamped in any position along its arc of movement.

Rudder and Propeller Action (Fig. 208). The propeller *always moves in the ahead direction*, and when the rudder plates are fully opened out its normal thrust will propel the boat ahead. But if the plates are nearly closed together abaft the propeller its ahead thrust will be neutralised by the backwash of its slipstream against the plates. If the plates are closed still further the backwash of the propeller slipstream against them will overcome the ahead thrust of the propeller and the boat will be propelled astern. Thus, by opening and closing the rudder plates the boat can be made to move ahead or astern at full, half, or slow speed, or be brought to a stop.

The boat is steered by the tiller in the same way as if she were fitted with an ordinary rudder, but when the tiller is moved the rudder effect of the plates is far greater and more effective at all speeds, and the boat will therefore answer her helm readily whether she is stopped, or going ahead or astern, however slowly or fast. When turning at rest the rudder will exert its greatest effect when the plates are fully closed.

The speed of the boat, ahead or astern, can be controlled by the combined use of the tiller wheel and engine throttle, or by the tiller wheel alone with the engine running at constant speed ahead. When lying alongside, however, the engine is throttled down to idling speed.

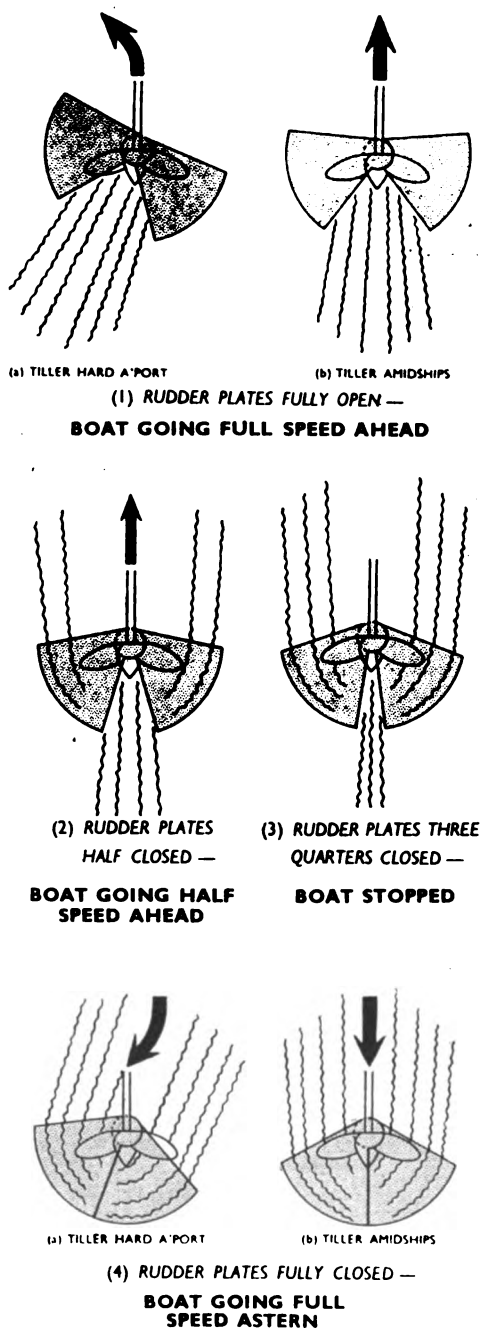


Fig. 208. The Kitchen rudder—rudder and propeller action

Handling Hard-chine Boats

A hard-chine boat is designed to plane on the surface of the water at a comparatively high speed, and therefore has a shallow draught, a flat bottom, and a greater beam than round-bilge boats of similar length.

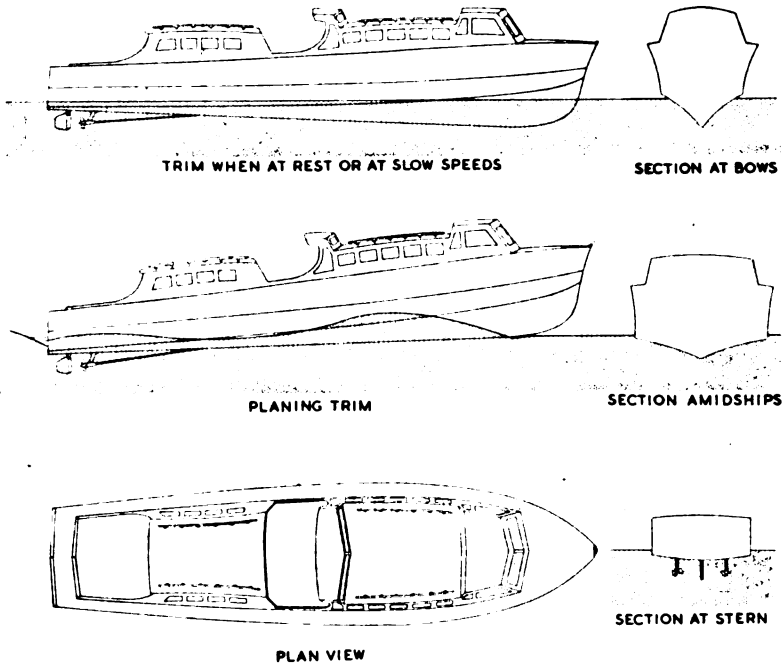


Fig. 209. A hard-chine boat

The trim of the boat and her steering qualities are very different at high and low speeds. From Fig. 209 it will be seen that the hull is of 'V'-shaped cross section forward and rectangular cross section aft, and when at rest or moving slowly her draught is greater forward than aft. When thus trimmed the boat's pivoting point is abreast or just abaft her bows, and because of her shallow draft abaft her bows she will tend to skid broadside on when under wheel, and her stern will swing well outside her turning circle. Because she is trimmed by the head the boat will answer sluggishly to her rudder, and when her propellers are at rest her rudder will have little or no effect.

On the other hand, when the boat is moving at speed in her planing trim the forward part of her hull is out of water and her stern is well immersed, and when thus trimmed her pivoting point will have moved well aft, her rudder will be well immersed and so have a good grip in the water, and she will answer readily to the lightest touch on the wheel.

The effect of the propellers on the steering qualities of the boat at slow speeds or when at rest will be similar to, but more marked than, that in round-bilge boats.

Under normal conditions the boat should be run at a speed which will allow her to attain her planing trim; if she is overloaded, however, she will be unable to attain it, with the result that she will plough sluggishly through the water,

be down by the head and probably ship water over the bows, and an undue load will be put on her engines and hull. Because of their shallow draft and high freeboard these boats are particularly susceptible to top-weight ; they should therefore never be overloaded, and passengers and stores should be stowed within the hull, never on deck or on the canopies.

The behaviour of a hard-chine boat in a seaway depends largely upon the length and steepness of the seas in relation to the length of the boat and her speed. In favourable conditions she will ride at high speed at her planing trim with comparative ease over seas which would be uncomfortable for a round-bilge boat ; but in unfavourable conditions she will bump so badly that her speed will have to be reduced below that required to keep her planing, and she will then wallow sluggishly in the seas and require very careful handling, particularly in a quartering sea.

HANDLING SINGLE-SCREW HARD-CHINE BOATS

Most of these boats have left-handed propellers, and remarks on their handling apply to those so fitted.

When manœuvring avoid declutching the propeller and allowing it to idle, because the rudder must have a flow of water past it to be effective. If, for example, the clutch is put into neutral when the boat is going slow ahead and swinging to port, putting the rudder hard-a-starboard will have no result and the boat will continue to swing to port.

If the boat is going ahead and the propeller is put astern, the stern will kick markedly to starboard ; and when the boat and propeller are both going astern the rudder has little effect unless the boat has considerable sternway.

This marked kick of the stern to starboard can be used to advantage to turn the boat at rest ; by giving her short bursts ahead and astern she can be turned to port almost in her own length, provided that the rudder is hard-a-port *before each burst ahead* because this is when the most pronounced turning effect is produced.

When going alongside, the boat should be kept on a steady approach course at an angle of 20° to 35° with the ship. If too much wheel is used after speed is reduced the boat will yaw and be difficult to steady ; steering at slow speed can only be achieved with practice. If the boat is to be placed starboard side to, go astern with the wheel a'midships and the kick of the propeller will bring the stern in. If the boat is to be placed port side to, put on plenty of starboard wheel just before going astern ; this will have the initial effect of swinging the stern in quickly, but the kick produced by the propeller on going astern will check the swing. The interval between putting the wheel over and going astern should be only a second or two, depending on the original angle of approach, and this again can only be judged with practice.

HANDLING TWIN-SCREW HARD-CHINE BOATS

In many of these boats both propellers rotate in the same way, *i.e.* both left-handed or both right-handed. Their handling is very similar to that of twin-screw round-bilge boats, but because of their shallow draft the kick of the propellers will be more marked.

If both propellers are right-handed the boat when at rest will turn better to starboard than to port, because the sideways thrusts of the port propeller going ahead and the starboard propeller going astern will kick the stern of the

boat in the required direction. If both propellers are left-handed the boat will turn better to port.

When going alongside approach on a steady course at a fine angle to the ship. Go astern with both engines and stop the inner one before headway is lost ; the outer propeller going astern will then stop the boat and swing the stern in. If steerage way is lost while going alongside, a kick ahead or astern on the appropriate engine will produce the desired effect. In the last stages of going alongside it is best to keep the rudder a'midships and manoeuvre the boat by her engines.

HANDLING TRIPLE-SCREW HARD-CHINE BOATS

A few boats are provided with three propellers, and when manoeuvring such boats it is best to stop the centre propeller and manoeuvre the boat as though she were a twin-screw boat ; the extra power of the centre propeller will be useful, however, if it is desired to reduce speed rapidly.

Handling Boats' Engines

It is important to realise that a boat's engine is called upon to perform a very arduous duty. The engine is usually running nearly at its full power while the boat is under way, it is frequently required to develop high power from cold with little or no warming up, and its hot running time is interspersed with periods when the engine is idling alongside ships' gangways. All these conditions tend to increase the rate of wear of the engine, which is expected to run for a certain number of hours between overhauls, usually between 1,000 and 4,000, according to its type.

The engines of Service boats are designed to fulfil these conditions, but they will only do so when handled with reasonable consideration and maintained strictly in accordance with the schedule laid down.

When a seaman rating takes over duty as coxswain of a boat he should, whenever possible, be given practical instruction by the Engine Room Department on the best method of handling the engines and their reversing gear.

Starting the Engine. It should be a matter of daily routine to check the amount of lubricating oil in the sump before first starting the engine, and also to make sure that the circulating water system is vented and flooded. The flow of circulating water and the lubricating oil pressure should always be checked before leaving the boom.

A warm engine should start without trouble ; failure to do so indicates that something is wrong, and technical assistance should be sought.

A very cold engine is more difficult to start for several reasons, the most usual being the thickening of the lubricating oil due to its low temperature, which reduces the speed at which the starter can turn the engine. Use of the correct grade of oil and regularly draining and refilling the sump in accordance with the maintenance schedule prevent this effect from becoming excessive.

The starting routine and control settings should be based on the instructions given in the engine-maker's handbook, and then be modified as necessary by actual trial and experience, as these will be found to vary even between engines of the same type. The routine finally selected should invariably be used. It should be realised that there is always a reason for any unusual difficulty

in starting ; if the starting routine is correct and the weather conditions not abnormal, technical assistance should be sought.

A cold engine should be warmed up fairly rapidly by running it at about half the full engine revolutions. Full speed should not be attempted until the engine is thoroughly warmed up.

It is most important to find the most suitable method of operating any starting aids such as " Kigas ". All starting aids must be used only as such ; once the engine is running they do no good and may cause rapid wear.

Stopping the Engine. If the maker's handbook advises any particular routine for stopping the engine it should be followed, because it is designed to leave the engine in the best condition for easy re-starting.

It is important that everything such as valves, cocks, and controls, should be left in the correct position when the crew leaves the boat. Accidents are frequently the result of leaving a cock or valve open which should normally have been left shut, and vice versa ; it is particularly easy to overlook such items when a boat is called away in emergency, and this may result in failure of the engine to start, or even in a breakdown.

When the engine or its gears have to be left in an unusual condition a note calling attention to the fact should be attached to the starting controls.

Running the Engine. The speed of the engine must always be kept well under control when manoeuvring, because an engine " running away " in neutral gear is subjected to stresses appreciably higher than those experienced when running steadily at full power.

The maximum power and revolutions per minute (r.p.m.) of most diesel-type boat engines are controlled by governors. Adjustments to the governors (or fuel lever stops where fitted) must not be made without the authority of an engineer officer. The diesel engine will always develop extra power if given extra fuel, but this extra power is obtained at the risk of serious breakdown. If correctly adjusted the governor will prevent overloading under normal conditions, but it will not necessarily do so when towing or when under other abnormal conditions, and coxswains of boats must ensure that under such conditions the boat's speed is reduced as necessary to avoid overloading. Any darkening of the colour of the exhaust gases, or labouring or overheating of the engine, are signs of overloading. Inability to reach the normal r.p.m. with the relative fuel setting also indicates that the engine is overloaded. The cause of a dirty exhaust should always be investigated without delay.

Petrol engines are less liable to overloading because the fall in r.p.m. reduces the quantity of petrol supplied by the carburetter, but caution is necessary when towing.

A boat should not be run when its clutch is slipping. A few minutes' running under these conditions may necessitate a major repair instead of a minor adjustment.

Sandy and Muddy Water. Running boats in sandy or muddy water is liable to result in choking the circulating water system. Their engines should be watched carefully for overheating, and if this occurs the engine speed should be reduced and the circulating system be cleaned out, or flushed out with clean water, at the first opportunity.

Signs of Defects. Some defects, such as misfiring and loss of power, are obvious. Others are less so, but most defects give some indication of their existence, among them being :

overheating ; smell (this points to the necessity for keeping an engine clean, a dirty engine will smell all the time thereby hiding this indication of trouble) ; noise ; vibration ; leakage (one example of which is an unexplained increase or decrease of oil etc., e.g. an increase in the oil level which may be caused by water leakage into the sump).

Boats' crews need not be trained to deduce the nature of a defect, but it is essential that they should be trained to be alert for indications of any defects.

Handling a Defective Engine. If running a boat with an untraced defect in the engine is unavoidable, it is usually safe to assume that the lower the speed of the boat and the power being generated by the engine the less is the danger of serious damage or complete breakdown ; but this rule must be modified if serious vibration occurs, in which case the lowest speed which is reasonably free from vibration should be chosen.

Propellers and Shafts. Propellers are vulnerable in almost all types of boats, but propellers, shafts and brackets of hard-chine boats are extremely susceptible to damage. Carelessly handling boats when alongside jetties, or running them in shallow water, will often incur a great deal of otherwise unnecessary maintenance work. Any abnormal vibration which may develop in the propeller system should be investigated without delay.

Maintenance of Engines

Each type of engine is assessed, according to its rating, power-to-weight ratio, and past experience of its wearing characteristics, to be capable of a certain number of hours running under normal conditions between major overhauls.

This overhaul period is based upon the assumption that the engine is properly maintained while in service.

Maintenance Schedules. Maintenance schedules, published in Admiralty Fleet Orders and subsequently reprinted as "S" forms, lay down the maintenance routines to be carried out between major overhauls. The technical departments concerned must be given the opportunity to carry out these routines, because failure to do so will cumulatively affect the engine's reliability. It must be remembered that these routines are based on normal conditions, and that additional and more frequent maintenance may be required if the engine has been subjected to abnormal usage.

Major Overhauls. The periodical major overhaul of the engine is a process of reconditioning designed to make the engine fit to run reliably for a further period of equal duration. To run the engine appreciably beyond the time when it is due for overhaul is to invite serious trouble, and may also seriously increase the cost and time of overhaul when this is undertaken.

Major overhauls require specialised equipment and must therefore be carried out in a dockyard whenever possible.

If the ship is at a place where there is considerable delay in obtaining replacement engines from the spare engine pool it is advisable to work the boats so that the dates on which their engines become due for overhaul will be well staggered.

Minor Defects. Even with good maintenance, minor defects may develop and lead to serious breakdown if neglected. The boat's crew is not normally competent to judge whether a minor defect is likely to cause major trouble,

so all defects should be reported without delay to the technical department concerned.

Water Danger. The petrol engine is very sensitive to water, particularly salt water, because of its electric ignition system. The diesel engine is far less sensitive to water because of its compression ignition system, but water will impair the functioning of its electric starting system. Furthermore, the metals of which both types of engine are made are easily corroded by salt water. It is therefore bad practice to run a boat with leaky engine-room hatches, or to drive the boat in such a way that water is shipped down the engine-room ventilators.

Fire Danger. With petrol there is always danger from fire. Being heavier than air petrol vapour collects near the bilges, and the absence of any smell of petrol when standing up in the engine compartment is no guarantee of freedom from this vapour. Where fitted, exhaust fans must be run for a minimum period of 10 minutes before starting.

The necessary precautions to guard against fire are laid down in the *King's Regulations and Admiralty Instructions* and in various A.F.O.s, but the following points are often overlooked :

- (i) petrol vapour will seep from one compartment to another by most unexpected channels ;
- (ii) when starting up there is always a danger of fire from the engine back-firing, from short circuits due to damp on electric leads, and from the engine compartment having probably been without any form of ventilation for some time ;
- (iii) an insignificant petrol leak can lead to the destruction of the entire craft, and the less accessible the petrol joint the more important it is to inspect it frequently ;
- (iv) the gas oil or diesel fuel used for compression ignition engines does not usually give off inflammable vapour, but this must not be allowed to lead to a complete lack of precautions ; although a diesel fuel fire is more difficult to start it is just as dangerous as, and sometimes more difficult to control than, a petrol fire.

Bilges. Water in the bilges is undesirable from every point of view. Apart from its endangering the boat's stability when present in considerable quantity, it usually contains salt which is dangerous and corrosive to electrical systems, and highly inflammable liquids such as petrol float on it and so increase the risk of fire. Bilges must therefore be kept dry, and bilge-clearing arrangements should be tested frequently and correctly maintained as thoroughly as the main machinery. Cleanliness of bilges is essential because the bilge-clearing arrangements can easily be choked, by dirt, cotton waste and cigarette ends, for example.

Cleanliness. Boat machinery requires real cleanliness, not polish, though polish is desirable as a finishing touch. Dirty machinery can be a danger to the safety of the boat.

Lubrication and Maintenance by Boat's Crew. All greasing and other hand lubrication must be carried out to a definite routine ; to do this when convenient is not good enough. The Boat Officer and others in charge of boats should arrange routine times for greasing and general maintenance duties.

The routine maintenance items for each type of boat engine are laid down in its "Maintenance Schedule". These schedules cover only the engine and its ancillary gear; all other working parts, such as controls, steering gear, winches and anchor gear, and hatch and door hinges and clips, should be attended regularly according to a routine made out for each boat.

Technical Departments. The responsibility of the various technical departments for the boat's equipment is clearly laid down, and this division of responsibility should be strictly maintained. Much can be done to assist the technical departments by early reports of defects, by allowing them adequate time for maintenance, and by arranging trial trips for the boat when required.

On the other hand the technical departments can assist the Executive branch by arranging for competent artificers to take periodical trips in the boats to ensure that the machinery is in a satisfactory mechanical state.

The minor trouble and inconvenience of these arrangements will be more than repaid by the resulting increase in the boat's reliability.

SPECIAL BOAT OPERATIONS

Towing Pulling Boats

A lightly laden boat may be towed for a short distance in calm weather by her painter, which should be made fast with two or three turns round her towing bollard. If no bollard is provided a wooden bar should be passed through the bight of the painter and laid under the two foremost thwarts (see Fig. 210 (i)). A boat should never be towed direct from her stem ringbolt because this puts an unfair strain on the ringbolt and stem. The painter should

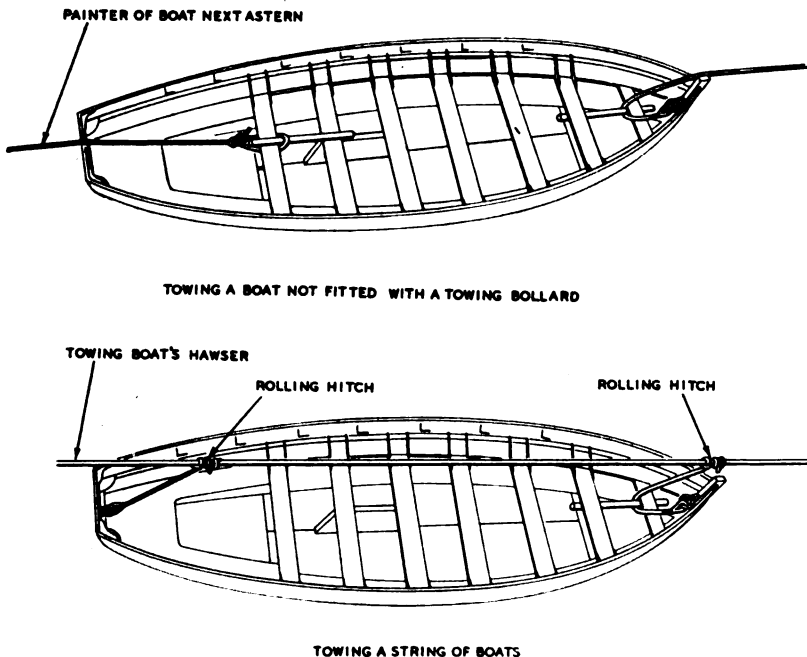


Fig. 210. Methods of towing pulling boats

be brought to the quarter bollard of the towing boat and tended by the sternsheetsman, who should be ready to cast it off at a moment's notice. One hand should be stationed in the bows of the towed boat ready to cut the tow in emergency, and the boat should be trimmed by the stern.

The length of the tow should be adjusted so that the forefoot of the boat rides on the crest of a wave in the wake of the towing boat. When a boat laden with men is to be towed a special towing painter is usually provided, the end of which is brought to the towing bollard with four round turns and backed up by the bowman. When being towed in a heavy following sea a drogue should be streamed to prevent the boat from being carried along on the crest of a wave and possibly broaching to.

If a second boat is towed astern of the first a bowline should be made in the end of her painter and secured in the sternsheets of the first boat by a wooden bar passed through the bight of the bowline and laid across the two after thwarts (see Fig. 210).

When several boats are towed astern of each other they should be towed in the order of their size with the largest boat leading, and each should be secured to the boat ahead of her as described above. If they are to be towed for a considerable distance, the towing boat may provide a hawser to which each boat should be secured by her bow and stern painters with a rolling hitch (see Fig. 210(ii)) ; the hawser should be served to prevent it from being chafed at the bows and stern of each boat.

Beaching a Boat

Small boats can be beached by the crew getting out and distributing themselves equally each side of the boat, and then lifting and launching her shoreward.

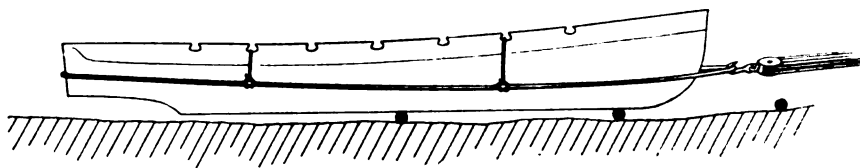


Fig. 211. Beaching a cutter

For beaching a heavier boat make a strop with the boat's cable, pass it round the boat just above the keel, and hang it in place by lanyards secured to the risings. Take three short spars to serve as rollers ; place the first one under the forefoot of the boat and the other two up the beach so that all three are spread about one-third of the boat's length apart. Then man the cable, or a purchase hooked on to it, and haul the boat up the beach, taking care to keep her on an even keel and to keep her bilges clear of rocks or large stones. As the boat should be hauled above the high water mark it is easiest to beach her at high water. A boat should never be left unattended if beached below high water mark, because she will probably be damaged by bumping and broaching to when the rising tide reaches her.

Handling Boats in a Surf

SURF

The movement of water in a wave as it passes over the surface of the open sea is circular, backward from the trough to the base and then upward and forward to the crest. When the wave reaches shallow water its forward speed is reduced, and the momentum of its forward movement expends itself in increasing both its height and the violence of the forward and backward movements of the water within it. The wave thus grows steeper and rises to a sharp crest, until finally it breaks, falls forward and downward, and throws forward a mass of frothy unbuoyant water from the line where it broke. Breaking waves caused by tide-rips or by isolated submerged rocks, reefs and other underwater obstructions are called "breakers"; and one or more lines of breakers occurring along a shore or over an extensive shoal are known as "surf".

Surf may be caused by the swell from a storm hundreds of miles away, by the sea raised by a local onshore gale, or by a combination of both. Waves caused by either a swell or a sea will arrive at fairly regular intervals, but the intervals between those from a swell will be much longer; a combination of swell and sea will produce confused conditions, particularly if they come from different directions, and any resultant surf will be confused and unpredictable. It is therefore easier to negotiate surf from a swell than surf from a sea; and the most difficult to negotiate is that from a combination of the two.

The extent of surf seaward from a coastline depends chiefly on the gradient at which the bottom shoals to the shore. Over a gently shelving bottom a heavy swell may produce surf extending for as much as a mile seaward, whereas the same swell on a steeply shelving bottom may only produce one line of breakers. In tidal waters the extent of surf may vary with the state of the tide, particularly when the tidal range is large and where the bottom shoals gently to the low water mark and thence more steeply to the high water mark; at such places the surf will be more extensive at low water than at high water.

The intensity of inshore surf depends chiefly upon the height of the waves, the speed of their advance, and the gradient of the bottom; high and rapidly advancing waves which pass abruptly from deep to shallow water will produce a dangerous belt of surf, whereas the surf produced by the same waves if advancing over a gradually shoaling bottom will not be nearly so intense. In tidal waters the intensity of a surf may vary with the state of the tide, particularly when the tidal range is large and the bottom shoals gently to the low water mark and thence more steeply to the high water mark; at such places the surf will be more intense at high water than at low water.

The degree of surf, both in extent and intensity, which may occur on a beach can therefore be roughly gauged from the gradient of the bottom; and in tidal waters it can be gauged from the gradients of the bottom and the beach, and from the range of the tide.

The position at which any particular wave may be expected to break depends upon its height and speed of advance, and upon the depth of water. Though the speed of advance of all waves in any particular sea or swell is about the same, there is usually a considerable difference in their height, and the larger waves will break further offshore than the smaller waves; also, in tidal waters, all the waves will break closer inshore at high water than at low water (see Fig. 212). It is the breaking wave which presents the greatest danger to

boats negotiating a surf; the "danger area" of a surf, therefore, extends from the seaward line of these largest breakers to the inshore line of the smallest breakers, and to negotiate it safely in a boat requires an experienced coxswain and a well trained crew.

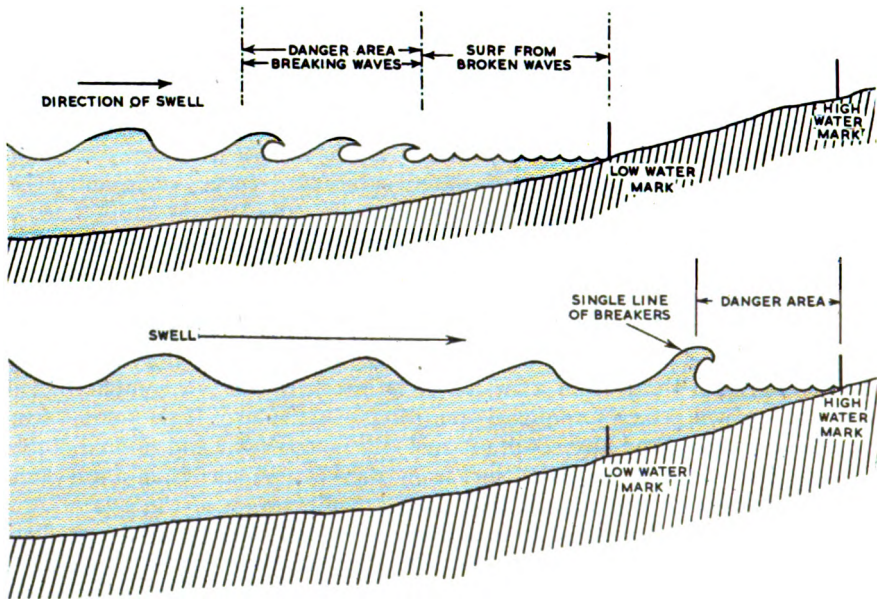


Fig. 212. Danger area of surf

Crossing this danger area would always be hazardous but for the fact that the waves usually advance over it in recurring cycles, of being first high and then gradually lower, with sufficient regularity to enable the coxswain of a boat to predict a comparatively calm period in which to cross (see Fig. 213). The correct prediction of these calm periods is essential to the safe negotiation of surf, and here it should be observed that the popular belief that the 7th, 5th or any other particular wave is the highest is quite fallacious.

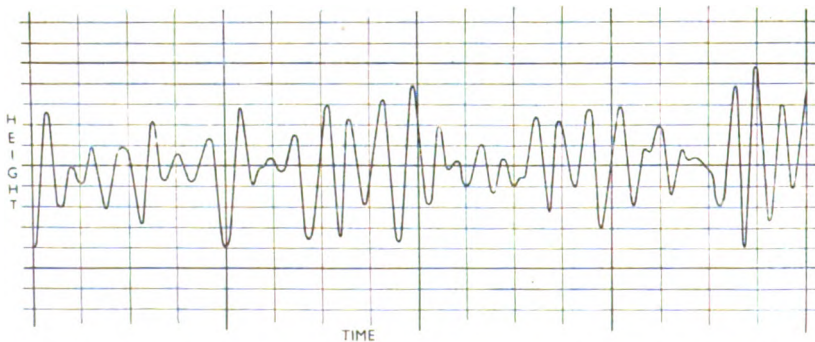


Fig. 213. Height : Time graph of a typical swell showing cycle of large and small waves

The degree of surf to be expected also depends upon the direction from which the sea or swell advances in relation to the direction in which the shore lies, and upon the shape of the beach. Where the sea or swell runs parallel with the shore far less surf can be expected than where the waves are rolling directly into a bay. A sea or swell running into a wide bay will cause a fairly regular surf over the whole, but waves running into a deeply indented bay tend to rebound from one side of the other and thus cause a cross swell and confused surf.

Undertow. A peculiarity of surf, particularly in shallow water, is the undertow in front of a wave which is about to break. This is caused by the water in front of the wave being drawn rapidly into the base of the front of the wave as it curls upwards and forward and then breaks. If caught unawares a man wading in shallow surf may be overthrown, dragged by the undertow into an oncoming wave, then drawn further seaward into the next wave, and so on until he is drowned; when working on a beach in heavy surf men should therefore wear life-lines.

SELECTION OF A BOAT FOR LANDING IN A SURF

A boat to be used for landing in a surf should possess the following qualities :—

- (i) have sufficient freeboard to prevent her being swamped in the frothy unbuoyant water of surf;
- (ii) be sufficiently buoyant at each end to allow her to ride over the waves and not through them, and to allow one end to rise to a wave without submerging the other; she should not, however, be too lively, otherwise the crew will not be able to work the boat;
- (iii) have good powers of acceleration ahead or astern;
- (iv) have good manoeuvrability, both ahead and astern in all conditions and particularly when stopped or moving at the same speed as the water;
- (v) be light enough to be man-handled by her crew when beaching or launching.

A transomed boat is more liable to "surf ride", *i.e.* be carried shoreward on the forward slope of a wave or by fast moving surf, than a double-ended boat. She is also more difficult to steer in a following sea because, if not exactly stern on to it, an overtaking wave will bear more under one counter than the other and so make her yaw or even broach to; for the same reason she is less manoeuvrable than a double-ended boat when going astern.

A pulling boat is preferable to a small power boat because :—

- (i) when pitching, the propeller of a power boat may often be out of the water and so useless;
- (ii) a power boat has poor manoeuvring ability when going astern;
- (iii) a power boat has comparatively poor acceleration, particularly when going astern;
- (iv) a propeller does not grip the surf as effectively as do oars.

The boat should be fitted with buoyancy tanks in the bows and stern to provide additional buoyancy at each end and prevent any water in the boat from collecting there. Anything of weight in the boat should be stowed amidships.

A double-banked pulling boat is preferable to a single-banked boat, and if possible she should be equipped with a set of short oars, shipped in long-jawed

crutches secured from jumping out of their sockets. Short oars are more easily handled in surf than long ones and are less likely to be unshipped by the surf from long-jawed crutches, and double-banking the boat gives increased power with maximum manoeuvrability and allows of the crew being evenly distributed amidships.

Steering. A boat's rudder is useless in surf because it has no effect when the boat is stopped or moving at the same speed as the water, and when pitching heavily it is useless through being frequently out of the water. Whatever type of boat is used she should therefore be steered by an oar shipped right aft in a closed crutch or a grommet, and if practicable her rudder should be unshipped; if the oar is shipped in a crutch the crutch should be secured to prevent it from jumping out of its socket.

NEGOTIATING A SURF

The chief dangers to a boat in surf are that a wave may break inboard, and that the boat may be carried shoreward out of control by the surf.

As a boat can manoeuvre more easily, move much faster, and accelerate much more quickly when going ahead than she can when going astern, surf should always be negotiated with the boat's bows pointing seaward, even when landing; she can thus be pulled quickly over a threatening wave, or pulled seaward vigorously to avoid riding either on the crest of a wave or in surf. Backing a boat shoreward through surf may be more tiring than pulling her, but she is always helped on by the general movement of the sea shoreward. Additional advantages of keeping the boat heading seaward are that:—

- (i) the coxswain is always facing the direction from which danger threatens;
- (ii) at the critical moment when the bows lift to a wave the steer oar is deeply immersed, thus ensuring full control of the boat;
- (iii) there is less chance of the steer oar being thrown by the seas from one side to the other and perhaps unseating the coxswain, or of its being wrenched from the coxswain's grasp;
- (iv) the oarsmen do not face in the direction from which danger threatens, and are therefore better able to concentrate on instantly obeying the coxswain's orders in unison;
- (v) a transomed boat is less liable to yaw or broach to.

A good surf boat should be capable of negotiating any surf caused by waves whose height does not exceed half the length of the boat. At night, however, owing to reduced visibility, it is not advisable to attempt to negotiate surf caused by waves whose height is more than one quarter or one third the length of the boat, according to the degree of visibility at the time.

Each occupant of the boat should wear a life-jacket, which if inflatable should be as fully inflated as the duties of the wearer allow. If the boat capsizes the occupants should immediately try to get to seaward of her to avoid being crushed by her pounding on the bottom, and from this position they can help to guide the boat as she is carried shoreward by the surf.

The coxswain should sit well up in the stern of the boat where he can get a good view forward over the heads of his crew. He should jam himself athwartships between the gunwales to obtain the maximum control of the steer oar and prevent himself from being pushed overboard by the oar should it take charge.

All orders to the crew should be short and sharp, and they should be obeyed *instantly*, and not one stroke after the order. If, for example, the crew are

holding water and the order "Give way", or "Back", is given, the crew should give a half stroke before their first full stroke in order to get way on the boat immediately.

Before each wave approaches, the boat should always be pointed at right angles to the line of the waves, and any tendency she may have to slew to one side or the other should be countered immediately by the steer oar. When landing through surf (stern first as directed) the stroke oarsmen should be detailed to keep a look-out for any rocks or other dangers directly astern of the boat.

Before negotiating a surf the coxswain should carefully survey it from seaward of the first line of breakers when landing, and from the highest vantage point ashore when putting to sea, to enable him to select the most favourable place in which to negotiate it. He should thus note the extent of the surf, the length and height of the seas, the interval between them, the extent and duration of the calm and rough periods, the direction and effects of any cross swell, the state of the tide, the gradient of the beach, the positions of any reefs, rocks or shoals, the extent of the danger area, and the probable effect of wind, current, or tidal stream on his course. Before leaving the ship the coxswain (or officer-in-charge if detailed) should also examine the largest scale chart, the appropriate volume of the *Admiralty Sailing Directions*, and the *Admiralty Tide Tables*, and also obtain any local information that is available.

Having selected the best position from which to enter the surf he should select the right moment at which to enter it. If entering from seaward this will be on the heels of the last of a series of high waves, so that he will, if possible, be able to cross the danger area in a calm period; if entering from the shore it will be immediately after such a wave has broken on the beach, so that the ensuing calm period will give him time to make a good offing before the next high waves approach.

The use of warps to haul boats through surf, either seaward or shoreward is not recommended. Warps restrict the movement of the boat, their weight tends to immerse deeper the end of the boat to which they are secured, and they may prevent her escaping from a breaker or drag her into one. If tended on shore, or in a vessel to seaward, the men manning the warp cannot foresee or appreciate the actual conditions in the danger area; if tended in the boat a warp is difficult to handle because of her violent motion, and the crew would be better employed in manoeuvring her. There is also usually a current, tidal stream, wind, or cross swell, which will set the boat to one side or the other of her course so that the warp would grow out on the bow or quarter, slew her off her course, and probably cause her to broach to.

It is possible, however, for a power boat under way outside the breakers to tow a heavily laden, undermanned boat seaward through light surf. The tow-rope should be secured as low down as possible to the stem of the boat, through her "rifle" if one is fitted. The line of tow should be kept at right angles to the waves, and good communication, preferably by telephone, should be maintained between the boats.

A drogue should always be used when pulling or running before a heavy swell or sea, particularly when crossing the bar of a tidal estuary or harbour, because it keeps the stern of the boat to the waves and prevents her from sheering to either side of her course and from riding on the crest of a wave (see Fig. 214). When landing through surf, however, the advisability of using a drogue depends upon the type of boat and the nature of the surf. It is most

useful for the larger power-driven craft, which can be taken in bows first to the beach, but if used for a small lightly manned pulling boat it is likely to hamper her manoeuvrability, and if the boat is set to either side of her course by the wind or current it may grow out on her bow and cause her to broach to.

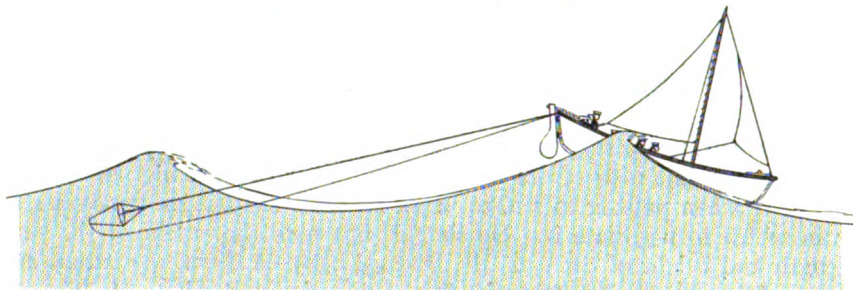


Fig. 214. Use of a drogue when running before a heavy swell

PROCEDURE FOR LANDING IN A SURF

The coxswain should cruise seaward of the outer line of breakers, select his point of entry into the surf, and then turn the boat stern to shore and at right angles to the waves and keep her there until a favourable opportunity occurs for crossing the first line of breakers. Just before the start of a relatively calm spell he should back his boat smartly so as to enter the danger area on the heel of a wave, and then continue his progress shoreward by backing, but resting on the oars and holding water or giving way, as required, to avoid a breaking wave or being carried along either on the crest of a wave or in surf.

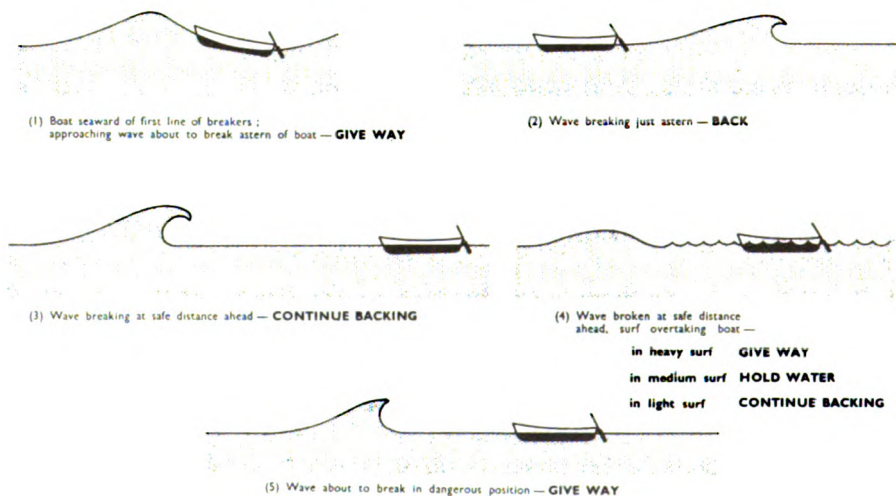


Fig. 215. Going shoreward through surf

The best position for a boat in relation to a breaking wave is at least two boat's lengths ahead of it. The boat should continue backing until the surf reaches her, when, to avoid being carried along with it, her crew should hold water or give way according to its intensity; then, when it expends itself, backing should be continued. If it appears impossible to avoid a breaking

wave it is better to pull seaward through it as hard as possible than to try and escape it by backing shoreward ; the wave is thus crossed in the shortest time, the boat should remain upright and pointing in the right direction, and, though she may be swamped, her reserve of buoyancy will keep her afloat ; whereas if backed, she will be carried shoreward out of control by the surf and will probably broach to.

Beaching. The procedure for beaching in a surf will necessarily differ with the conditions prevailing. In light surf with only small waves breaking close inshore, as will often occur at or near the time of low water, the boat can be beached more deliberately than in a heavy surf at high water when there may be only one line of breakers of dangerous proportions and the boat must be beached and hauled clear of the breakers as quickly as possible. The two different procedures are detailed below.

In light surf on a gradually shelving shore. On reaching shallow water the coxswain boats his steer oar, and he and the two stroke oarsmen jump out and hold the boat stern on to the beach while the remainder of the crew continue backing and keep the boat bows on to the waves. As the boat grounds, the coxswain orders the crew to get out smartly, in pairs from aft forward, the bowmen being the last to leave (the crew leave in this order because the forward oarsmen are required to keep the boat bows on to the surf until the last possible moment) ; then, seizing the gunwale abreast their respective thwarts, the crew haul the boat smartly up the beach clear of the water.

In heavy surf when the beach is steep-to. Under these conditions the line of breakers must be crossed and the boat beached in the shortest possible time, not only to avoid the breaking waves but also to avoid the strong undertow. As before, the coxswain should turn the boat stern to shore, and when a favourable opportunity occurs the boat must be backed smartly inshore on the back of the last of a series of high waves. Immediately the boat grounds the coxswain orders the whole crew to jump out and haul the boat clear of the water as quickly as possible. If the boat is not hauled up before the next wave breaks there is a chance that both boat and crew will be dragged into it by the undertow.

PUTTING TO SEA THROUGH SURF

The boat is prepared for launching by shipping the oars in their crutches and laying them athwart the gunwales of the boat. The crew then station themselves round both sides just before their respective thwarts, grasp the gunwale, and haul the boat to the water's edge, bows seaward.

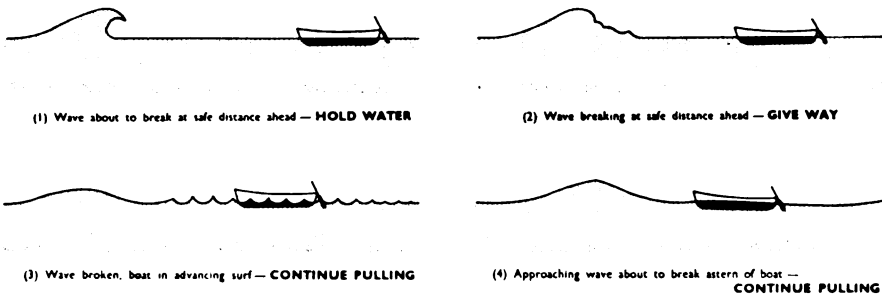


Fig. 216. Going seaward through surf

Then, as in landing, the actual procedure for putting to sea depends upon the conditions obtaining at the time of launching the boat.

In light surf on a gradually shelving shore. When an opportune moment occurs the crew launch the boat smartly by order from the coxswain; and as soon as she is afloat the coxswain orders the bow oarsmen into the boat. They jump in, man the oars, and keep the bows pointing seaward while the remainder of the crew keep the boat steady and stern on to the beach. In quick succession the coxswain orders the remainder of the crew into the boat, in pairs from forward aft, and as each pair jumps in they man their oars. Finally the two stroke oarsmen and the coxswain jump into the boat, and she is pulled smartly seaward. In practice the stages of this operation are carried out rapidly one after the other.

In heavy surf on a steep-to beach. The boat must be launched between two successive waves and pulled seaward of the line of breakers before the oncoming wave breaks; speed and accurate timing are therefore essential. The coxswain should wait for a calm spell and then launch his boat immediately a wave breaks. The crew then run the boat as fast as possible into the surf, jump into her together as soon as she is well afloat, and immediately get their oars out and pull seaward as hard as possible, without further orders, until the boat has crossed the line of breakers. This operation calls for a high degree of skill on the part of both coxswain and crew.

When pulling seaward through surf the coxswain must judge accurately where the next wave is going to break, and manoeuvre his boat so that she either crosses the wave before it breaks or is two to three lengths shoreward of the wave when it breaks. The crew must pull smartly when passing over a wave, and as hard as possible through the surf of a broken wave. To cross the danger area in a calm spell when putting to sea the crew will have to pull with the utmost vigour.

SURF-RIDING

The term "surf-riding" is used to describe both riding a boat on the crest of an unbroken wave and riding her on the surf of a broken wave. Surf-riding is not recommended, either when running before a following sea or swell or for landing in a surf, because it is dangerous unless carried out by highly skilled and experienced men in specially designed craft. In special circumstances, however, it may have to be resorted to for crossing a stretch of water quickly, or landing quickly through surf; in the latter case the momentum gained by riding on the crest of a wave is used to carry the boat through one, or at the most two, lines of breakers onto the beach or over a reef into a lagoon.

For surf-riding a boat should be light, have fine lines, be very buoyant forward, decked in aft, and trimmed so that her centre of gravity lies at one third the length of the boat from the stern. Instead of oars she should have a double bank of paddles, these being easier to handle and having a better grip in surf because they can be dug deeply into the water, thus enabling quicker acceleration.

To surf-ride on a wave the boat must be given sufficient initial momentum to place and keep her on its front slope, with her stern just below its crest. In this position the weight of the boat tends to push her down the forward slope of the wave, but this is counterbalanced by the wave's rapid forward movement, so that the boat remains balanced and is carried forward with the wave.

This position, however, is very precarious, because the boat is forced through the water at the speed of the wave, which can be as great as 15 knots, and the effect of the slightest yaw to either side of her course at such a speed will, unless immediately countered, slew the boat broadside on so that she broaches to and capsizes. There is also the danger of the weight of the boat causing her to overrun the swell and dig her bows into the trough, which may well broach her to or upend her. Her crew must therefore endeavour to keep the boat balanced on the forward slope of the wave, and the coxswain must immediately correct any tendency to yaw. If the wave overtakes the boat no harm will result provided that the coxswain can keep her from slewing off her course.

To surf-ride, the boat is turned with her stern to the swell, and the crew are ordered to paddle "flat out" when a wave is about 15 or 20 yards astern of her, the actual distance depending on the length of the swell. The crew then paddle the boat ahead as fast as possible until they are overtaken by the wave and the boat starts to ride on its front slope; they then cease paddling and the boat is kept on a steady course by the coxswain. When the surf line is reached the crew must be prepared to act quickly. As the wave is about to break its forward movement is at once retarded so that it piles up and the boat is carried forward by her own momentum into the undertow ahead of the wave; the crew must then immediately paddle hard to keep ahead of the wave until it breaks just astern of the boat, and the resultant surf will then overtake her and carry her onto the beach, where the crew at once jump out together and run her up. The critical period is when the advance of the wave is retarded and the boat plunges into the undertow. If then she slews off her course she will probably broach to; if so, the crew must get clear and to seaward of the boat as quickly as possible, and with luck the surf will then carry both boat and crew onto the beach.

Landing on a Rocky Shore

Men can be landed on, or embarked from, a deeply shelving rocky shore in weather suitable for boat work if the landing place is clear of surf and it has a good approach from seaward; (as used here the word surf means that caused by waves breaking before they reach the shore, and not the froth caused by waves breaking on it).

The most suitable boat for this operation is a double-ended power boat with good astern power and manoeuvrability. A strong warping bollard should be fitted in her stern, and she should carry an anchor with good holding power and a warp of sufficient length; (for depths of up to 3 fathoms; a 20-fathom warp is required).

The anchor is dropped, as a kedge, to seaward of the selected landing place and within warping distance of it, and the boat is then run in to the landing place while the warp is paid out astern. The final stage of the approach is made cautiously, with the warp kept taut, until the boats bows are 2 or 3 feet from the shore. The warp is then belayed and the boat kept in position by running the engines slow ahead, the bowman then jumps ashore and keeps the bows steady with the painter, and the passengers then jump ashore (or on board), timing their jump with the scend and surge of the boat. When the embarkation or disembarkation is completed the boat is warped astern to the anchor which is then weighed.

The best conditions for this operation are when the sea or swell is heading directly towards the landing place so that the boat can approach with it directly astern of her, and landing should not be attempted if the angle between the line of the shore and the direction of sea or swell is less than 45° . Wind and tidal stream, or current, and outlying rocks, may affect the selection of the line of approach, but it should be clear of rocks to avoid fouling the warp and should be as nearly down sea or swell as practicable.

Before the anchor is dropped from the stern a length of warp equal to the depth of water must be streamed from the bows to ensure that the anchor drops straight to the bottom and clear of its warp. When half way between the position of the anchor and the landing place the hold of the anchor should be tested; if it comes home it must be weighed and dropped again in another place. The longer the scope of the warp the better will the anchor hold.

Boarding a Vessel at Sea

The vessel to be boarded will probably make a lee for the boarding boat by lying hove to with the wind and sea at some point between abeam and broad on the bow, as best suits her. The boarding vessel will probably lower and slip her boat in the other vessel's lee, and remain in this position with her stern to the other vessel until she has recovered her boat.

A ship should almost always be boarded on her lee side, and the best position is where her freeboard is lowest, and as near amidships as possible, where the vessel's pitching and yawing will be least felt. When boarding an "island freighter" the best position will be abreast the fore end of her after well deck, or the after end of her fore well deck, according to whether she is lying with her bow or quarter to the sea. On no account should an attempt be made to board a ship's weather side, because the seas will fling the boat against it and probably smash her up or swamp her. If the ship is lying beam on to the sea there will probably be a considerable swirl and backwash round her bows and stern, and if lying with the sea on her bow and pitching there will probably be a considerable swirl and undertow at her bows and especially at her stern; a boat should therefore always give a wide berth to the bows and stern of a vessel hove to. If the ship is using her engines to keep steerage way as wide a berth as possible should be given to her propellers, especially ahead of them, as otherwise the boat may be drawn into their wash and swamped.

The vessel being boarded should provide, at the boarding position, pudding fenders lowered to the waterline, a jumping ladder and life-line, and a long boat-rope which should have a long eye spliced in its end and be led well forward so as to allow the boat to rise and fall on the waves independently of the ship. While the boat is alongside a hand should be stationed in her bows to slip or cut the boat-rope immediately should the need arise. When the boat leaves, the ship boarded should continue to provide a lee for her until she is hoisted aboard the boarding vessel.

Some ships, particularly coasters and cross-channel packets, are fitted with a rubbing strake which projects from the ship's side just above the waterline and constitutes a serious menace to boarding-boats. The best way of fending the boat off such ships is by oars or spars held vertically between the boat and the ship's side in such a manner that the side of the boat rides on the oars or spars as she rises and falls, and thus prevents her gunwale from getting under the rubbing strake.

Boarding a Wreck

Unless bows or stern on to wind and sea, a stranded ship affords a good lee for a boat and so should be boarded on her lee side if clear of wreckage and the depth of water allows ; if not clear it may be possible to board her over her bows or stern. If the only possible approach is from windward it may be possible to get within heaving line distance by anchoring the boat some distance to windward of her and then dropping down on her by veering cable.

If there are signs of panic or disorder on board the wreck the boat should not attempt to go alongside, but should lie off, stern on to the wreck, and haul survivors to the boat one by one on a line.

Recovering Torpedoes

The recovery of torpedoes after they have completed their run calls for good seamanship, and should be carried out as speedily as possible as the torpedo may sink unexpectedly and be lost. There are different methods of recovery, the choice of which depends upon the type of recovery vessel and the state of the sea, but in each the essentials are : good handling of the recovery ship, speed in grappling the torpedo when it has surfaced, and avoidance of damage to the torpedo and recovery equipment. A whaler or other boat from the recovery vessel is generally used.

Preparation in the Recovery Boat. A whaler is the most convenient boat for recovery because of her low freeboard and small crew. To counter the drag of the torpedo three oars are used on the side to which it will be secured and two on the other, so the crutches should be shipped accordingly ; the torpedo is, of course, secured to the side of the boat which will be next to the ship's side when she goes alongside. The sailing tiller must be used because the mizzenmast tabernacle must be free for securing the inboard end of the tail line.

Two nose and two tail lines should be put in the boat. One pair should be made ready by reeving the nose line through the running eye of the tail line, so that the tail line can be dropped over the nose of the torpedo when the nose line has been hooked on ; a light stop to keep the bight of the tail line open is advisable. The nose line and the bight of the tail line should be in the head-sheets, and the tail line should be led outside the boat and lightly stopped to the rubber.

The torpedo rating in the boat should wear a lanyard with a stop valve attached.

Two fenders, each made of 5-inch grass tailed with 1-inch line and secured to a thwart and the bilge rail, should be secured on the towing side to protect the boat from the torpedo.

Preparation in the Recovery Ship. If a crane is used for hoisting in torpedoes a steadying line should be secured close to the ponders ball and tended on deck to prevent the ponders ball from swinging as the ship rolls.

Long sausage fenders should be placed over the ship's side to protect both the torpedo and the ship's side from damage.

A boat-rope and sternfast should be rove ready for passing down to the recovery boat ; heaving lines should not be used to keep her alongside.

The ribbon strop (a plaited wire strop used to sling the torpedo) should be made up in two turns with the soft eye rove just through the thimble eye and stopped with twine.

If the deck is of wood, lime should be put down on it to prevent it from being stained by oil from the torpedo, and painted deck cloths should also be used, especially if the torpedo is to stand on a trolley in the sun for any length of time.

Boatwork. Torpedoes, except those electrically propelled, float vertically, tail down, when they have finished their run. The boat should be brought to the torpedo from leeward and manoeuvred so that the nose of the torpedo lies under her weather bow until the nose line is hooked on by the torpedoman stationed in her bows. The torpedo must then be secured on the side of the boat which will be next to the ship's side when she comes alongside for it to be hoisted in.

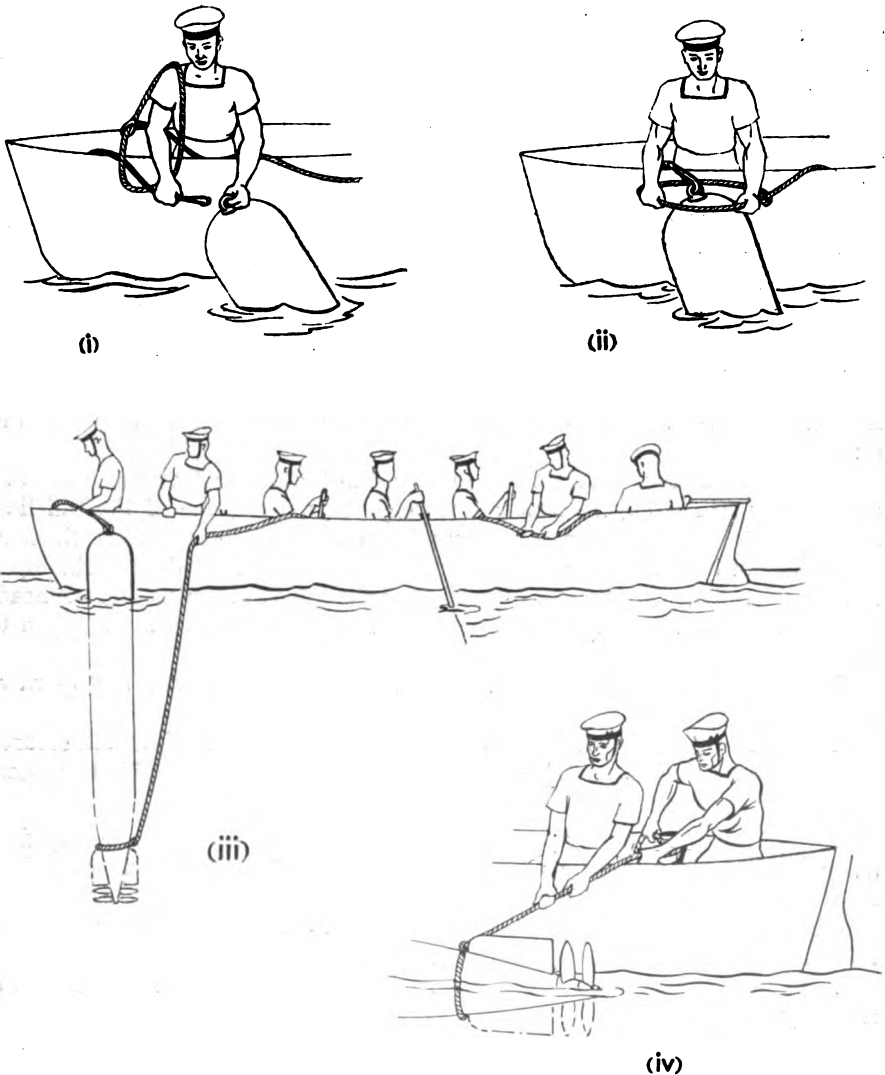


Fig. 217. Securing a torpedo alongside a whaler

The nose line is passed through the bight of the tail line and hooked to the eyebolt in the head of the torpedo (see Fig. 217 (i)) ; it is then secured, on the bight, to the bow thwart sufficient slack being allowed for the torpedo to tow easily without unhooking. The tail line is then dropped over the nose of the torpedo and allowed to slide down to the tail (Fig. 217 (ii) and (iii)) ; it is unlikely to fall right off the tail, but to ensure against this happening the tail line should be marked so that when held at the mark it will be too short to slip over the tail.

When the tail line is in place it is hauled in to the sternsheets to raise the tail of the torpedo as high as possible (Fig. 217 (iv)), and then belayed to the mizzenmast tabernacle ; raising the tail is made easier if some way is given to the boat while the hands haul away on the line. In practice the torpedo is usually towed slightly down by the tail, because there is not room in the sternsheets for sufficient hands to man the tail line to haul the torpedo horizontal.

When the torpedo is properly secured the torpedoman in the sternsheets closes the stop-valve, puts the air lever forward, and, if possible, lashes on a propeller clamp.

Hooking On. When the boat is within reach of the ship the boat-rope and sternfast are passed down to her ; they should be secured as far forward and aft in the boat as possible. The inner oars should be shipped, but the outer oars should be laid across the gunwales and their looms used to bear the boat and torpedo off the ship's side.

The nose and tail lines should then be passed up to the ship and secured so that they take the weight of the torpedo off the boat. The nose line is rove through the ribbon strop, which is lowered down to the nose of the torpedo ; (see Fig. 218 (i)). If the torpedo is tail down a slight kick ahead on the ship's engines will bring it up much more quickly and effectively than hauling away on the tail line.

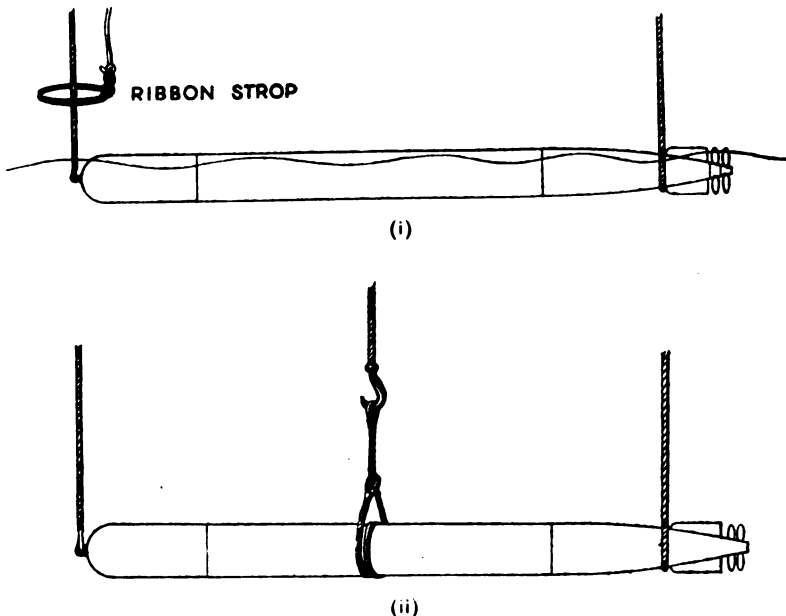


Fig. 218. Passing a ribbon strop

The ribbon strop, which is now rove round the torpedo with its soft eye passed through its thimble eye and kept open by light stops, is worked aft along the torpedo to the point of balance ; this point may be marked on the torpedo, but the torpedo rating should always ascertain it beforehand from the Torpedo Officer. The purchase is then lowered and hooked on to the soft eye of the ribbon strop (see Fig. 218 (ii)) ; it must be correctly plumbed or the torpedo will surge when hoisted and endanger the boat and crew. When the purchase has taken the weight and all is well, the boat is hauled clear and the torpedo then hoisted inboard.

Other methods of recovery by whaler. An alternative method when using a whaler is to pull her with six short oars manned from the three midship thwarts ; this requires more hands but leaves the headsheets and sternsheets clear for hauling on the nose and tail lines.

Another method is to tow the whaler alongside on a boat-rope ; the ship reduces speed on nearing the torpedo, the whaler sheers out under helm and secures the torpedo, and both are then hauled alongside. The whaler must be ready to slip her boat-rope and use her oars in emergency, or if the approach is misjudged.

Recovery by cutter. To avoid heavy strains coming on the gunwale the forward poppet should be unshipped and the nose line led through the rowlock ; otherwise the procedure is the same as by whaler.

Recovery by power boat. Power boats are sometimes used for recovering one or more torpedoes, the torpedoes being towed astern. If high-speed boats are used the torpedo's propellers may trail and so set on range and restart the torpedo engine, which may cause the torpedo to run again and possibly ram the boat ; the following precautions must therefore be taken before towing the torpedo :—

- (i) the stop-valve must be closed ;
- (ii) the air lever must be pushed forward ;
- (iii) the propellers must either be jammed with rope, or a propeller clamp must be lashed on them.

RECOVERY WITHOUT USING BOATS

In calm weather with destroyers and other similar and easily handled ships, torpedoes can be recovered without using a boat. A hazel-wood or other stout fender of suitable length is slung horizontally, close to the water line, and a jumping ladder is slung between its lanyards. The recovery ship manoeuvres so as to bring the torpedo within reach of the deck or the fender, from which a man then hooks on the nose line, either by using a Davey hook or by fitting the recovery hook on the end of a bamboo stave which is withdrawn after the hook is engaged. Assisted by a kick ahead with the ship's engines the torpedo is hauled up to a horizontal position, and the ribbon strop is passed down the nose line and adjusted on the torpedo by the man standing on the fender. To assist in passing the ribbon strop down the body of the torpedo the bight of the strop can be kept open by stopping it to a rattan cane grommet strop.

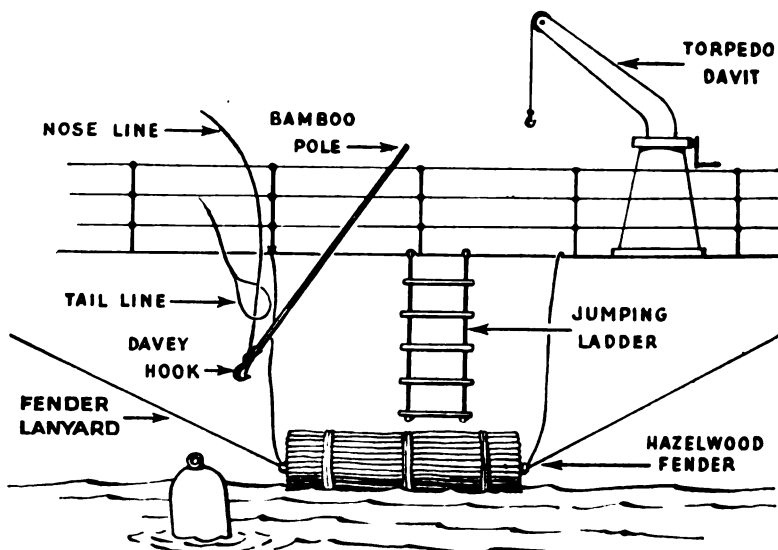


Fig. 219. Recovering a torpedo without using a boat

GENERAL NOTES ON RECOVERING TORPEDOES

When towing a torpedo the nose line should be shackled on to the torpedo if it has to be towed astern of a boat for any distance.

When a torpedo is alongside a ship it must not be allowed to lie alongside longer than is absolutely necessary, as it is then liable to suffer damage and may get under the bilge keel; while alongside it also hampers the handling of the ship, and often those on the bridge cannot see what is happening to it. Hand flags or a telephone should always be used to inform the bridge of the position of the torpedo and to indicate each stage reached in its recovery.

When more than one boat is used to pick up several torpedoes each should carry a ribbon stop, which should be passed round her torpedo while she is waiting her turn to come alongside, thus saving much time.

Handling torpedoes not fitted with a nose eye-bolt or wire rope becket. Some torpedoes may not be fitted with an eye-bolt or wire rope becket in the nose of the collision head, so that the only way of towing them is tail first. The tail line should be well served and padded to prevent it from damaging the propellers, and the torpedo should be towed at slow speed to prevent straining the after-body, which is its weakest part.

Sweeping for Sunken Torpedoes or Other Lost Objects

The recovery of a sunken torpedo by sweeping is not a difficult operation if the position in which it was lost is buoyed and the sweeping operations are properly carried out. The method advocated here is equally effective for locating and recovering any sunken object large enough to be "felt" on the sweep wire.

The operation is divided into three phases :—

- (i) marking the position of the lost torpedo ;
- (ii) locating the torpedo with the sweep ; and
- (iii) recovering it.

PREPARATION

Before starting operations the sweeping officer should obtain the following information :—

- (i) a description of the torpedo, including its weight and buoyancy, and the likelihood of there being air, oil, or other traceable leaks ;
- (ii) the angle at which the torpedo may be lying ;
- (iii) the nature of the bottom ;
- (iv) the depth of the water ;
- (v) the direction and strength of any current or tidal stream, the times of high and low water, and range of the tide ;
- (vi) direction of the wind ;
- (vii) transit marks, if any, of the position of loss.

The following equipment should be provided for the sweeping boats :—

- (i) a chain sweep, ready for streaming ;
- (ii) two or more " blobs ", ready for streaming and with sinkers attached ;
- (iii) manila stops, strops, and securing lines ;
- (iv) sword matting or chafing pads ;
- (v) a 20-ton screw bow shackle ;
- (vi) 30 fathoms of 1½-inch tarred manila ;
- (vii) an axe ;
- (viii) leather gloves ;
- (ix) signalling equipment ;
- (x) a first-aid outfit.

Component Parts of the Sweep. It is recommended that the sweep should be made up as shown in Fig. 220. This sweep will be effective in depths of up to 20 fathoms, and in a tidal stream of up to nearly 3 knots.

LOCATING AND MARKING THE POSITION

Preliminary Survey. It is assumed that the ship reporting the loss of the torpedo will have buoyed its estimated position.

The sweeping boats must be organised to search a reasonably large area for any indication of the torpedo's position, such as air and oil bubbles and streaks and patches of oil on the surface. Some engine and shale oil will almost always rise to the surface from a sunken torpedo, so a boat should be sent down wind to scent for it ; the smell of such oil will often lead to the discovery of the tell-tale bubbles. Boats should be warned not to pump out their bilges during the search as this may lay a false scent.

On finding air bubbles a marking blob should be streamed and its sinker let go after making due allowance for the height of the tide and the depth of the water. If, after a protracted search, no signs of the torpedo can be found, a search by ground sweep must be made.

Having marked the position of the torpedo it must be decided whether to locate and recover it by diver or sweep. If the sweep is decided upon, sweeping buoys must then be laid down.

Laying the Sweeping Buoys. When the position of the torpedo has been marked by a buoy it should be fixed by taking transits of conspicuous landmarks.

Two sweeping buoys should then be laid across the stream in line with the mark buoy and about fifty yards on each side of it, thus forming the "sweeping gate" and the mark buoy can then be weighed; it should never be towed out of the area because its mooring may foul the gate moorings or the torpedo.

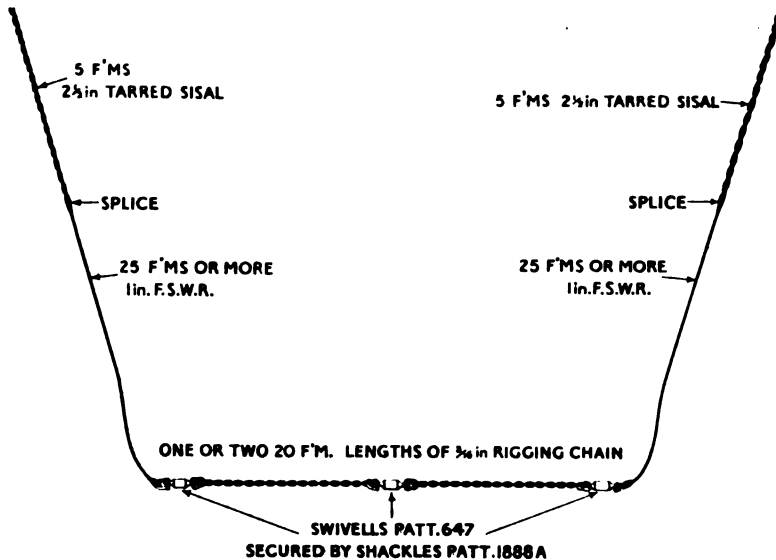


Fig. 220. Component parts of the sweep

SWEEPING AND RECOVERY

Boats work in pairs, that in which the sweep is carried being called the "working boat" and the other the "non-working boat". Both boats should stem the tidal stream or wind and sea well above the gate, and one end of the sweep should then be passed to the non-working boat. In each boat the tail of the sweep should be secured to a cleat on her outer bow, and then be led round her bows and along the gunwale to her inner quarter, care being taken to stop the tail clear of the water and of the boat's propellers (see Fig. 221 (i)). The bight of the sweep should then be paid out over the stern of the working boat, being checked as necessary to prevent the chain of the sweep from fouling itself.

The boats should then turn round to head towards the gate, open out to the effective limit of the sweep, and proceed slowly down stream (see Fig. 221 (ii)).

Speed must be kept low so that the sweep will not dislodge or under-run the torpedo. The feel of the sweep will indicate if an obstruction is encountered, and immediately any such indication is felt both boats should stop their engines and turn sharply inward so that the stream will sweep their sterns round and the boats be brought alongside each other heading upstream (see Fig. 221 (iii) and (iv)). During this manoeuvre the stops on the sweep tail in each boat should be cut so that it will stream clear of her side.

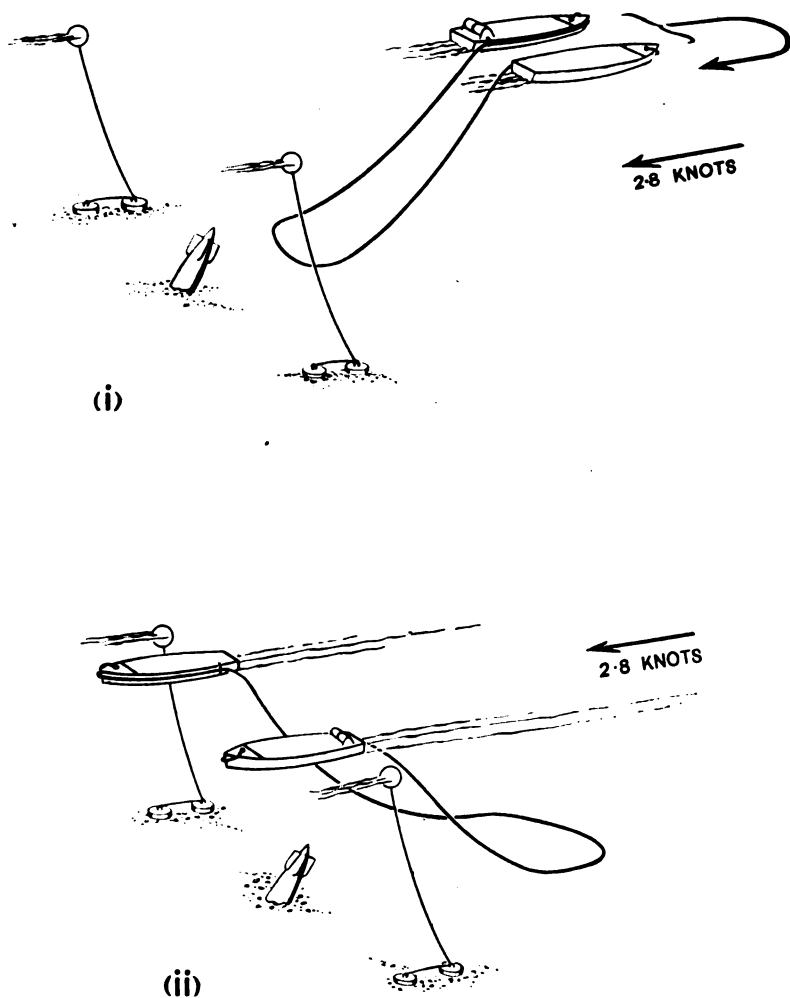


Fig. 221. Sweeping downstream with two boats

The working boat now takes both ends of the sweep over her bows and proceeds slowly towards the position in which the obstruction was located, the slack of both parts of the sweep being taken down by hand. When nearly over the located position a 20-ton bow screw shackle, tailed with a thirty-fathom half-inch manila messenger, should be shackled round both parts of the sweep and lowered to its full extent (see Fig. 221 (iv)) ; this operation must be carried out very carefully so as not to dislodge the bight of the sweep from the torpedo.

The strain is now equalised between the two parts of the sweep, and both parts are taken to the winch and hove in handsomely. If successful the bight of the sweep will hold against the projections on the torpedo (or other object), which can then be raised against the surface ; if it cannot be lifted by the boat, however, or if it appears doubtful that the sweep will hold it, the position should be buoyed immediately.

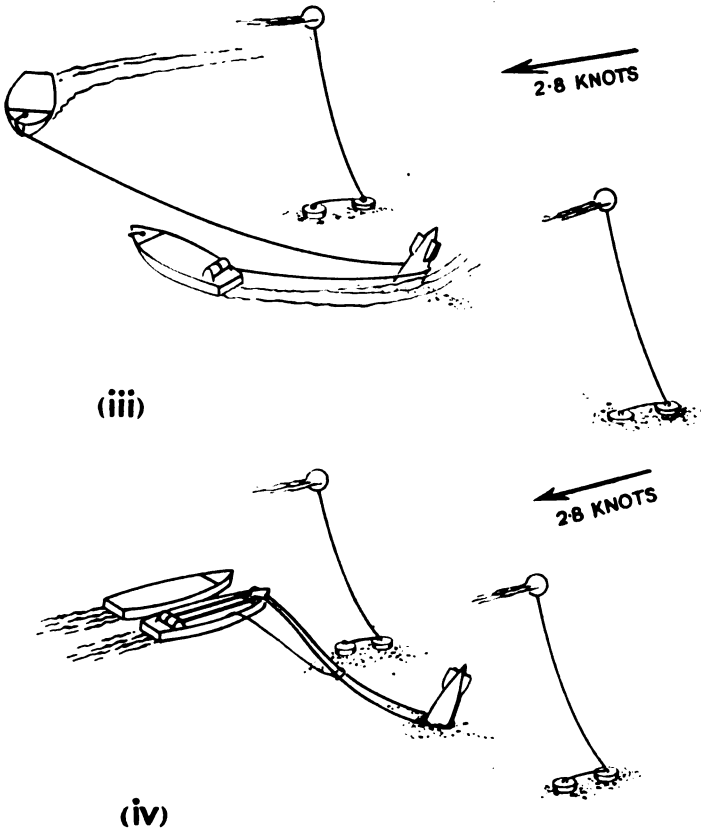


Fig. 21 (contd.). Sweeping downstream with two boats.

Sweeping Against the Stream. The disadvantage of sweeping against a tidal stream or current is that the sweep chain tends to lift instead of biting into the bottom, and so is liable to ride over any obstruction such as a torpedo. The sweep through the gate is carried out as already described except that the stream is stemmed; and when the torpedo is contacted by the sweep the boats are turned inward, but one passes inside the other, as shown in Fig. 222 (i), and they are then manoeuvred together down stream from the torpedo. The torpedo is then recovered in the manner described in the previous paragraph.

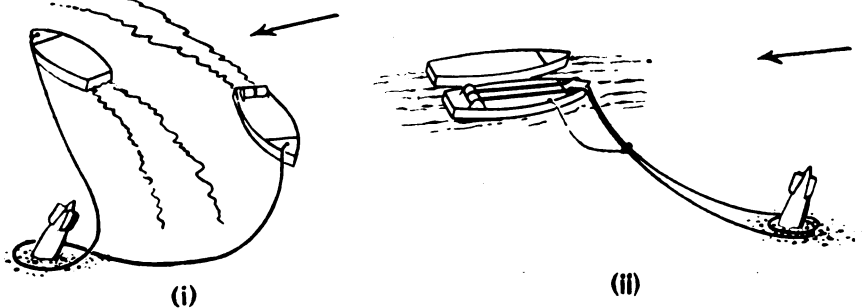


Fig. 222. Sweeping upstream with two boats

Single Boat Sweep. A grapnel sweep can be used with good results at slack water if the sea is calm and bubbles can easily be seen rising from the torpedo.

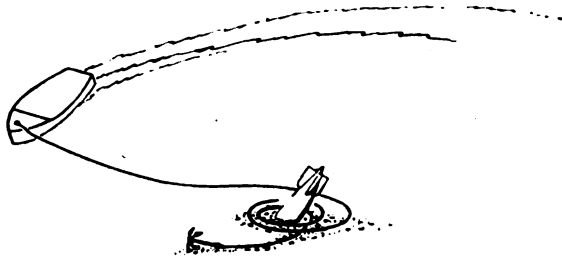


Fig. 223. Sweeping with one boat

The grapnel should be tailed with about 200 fathoms of $\frac{3}{4}$ -inch F.S.W.R. reeled on a small cable drum. It should be lowered to the bottom near the bubbles, and the boat then steered round the bubbles while the greater part of the wire is paid out (see Fig. 223). When sufficient turns have thus been laid round the torpedo any slack is taken in by hand and the weight of the boat is then used to tauten the turns. When no more slack can be taken up the torpedo is weighed by winch, or by hand if its negative buoyancy is not too great.

Diving from a Boat

Diving is work of a specialised nature, usually carried out by qualified divers under expert supervision in accordance with the instructions given in the *Diving Manual*, B.R. 155/43. The seaman should, however, know a certain amount about diving so that he can assist when divers are sent down from a ship's boat.

DIVER'S RIG

When underwater a diver is provided with a continuous supply of air through a rubber pipe, called an "air-pipe", which leads into his helmet from a hand or power-driven air-pump situated above water. A "breast-rope" of plaited hemp, which incorporates a telephone cable and by which the diver can be lowered to the bottom and hauled to the surface, is rove under the diver's right arm and secured to the back of his helmet; it is marked with knotted mackerel line at 10-ft. intervals up to 30 fathoms. The breast-rope also serves as an alternative means of communication between the diver and his attendants if telephonic communication fails, who then signal their requirements to one another by jerking the breast-rope in conformity with a special code. The air-pipe and breast-rope are tended continuously while the diver is underwater.

The diver is also provided with a "shot-rope" of 3-inch tarred sisal which acts as a marker, one end being bent to a sinker and the other secured in the boat adjacent to the diving ladder. By means of a "distance line" consisting of 5 fathoms of $1\frac{1}{4}$ -inch tarred sisal spliced into the shot-rope about 3 ft. above the sinker, the diver can search a circular area of about 300 square yards round the sinker. The shot-rope can also be used to guide gear down to the diver, the gear being attached to a lizard, or a messenger, which runs up and down the shot-rope.

All cordage used for diving should be tarred, because it is then not so slippery when wet as is white rope.

LIMITATIONS OF A DIVER

A diver's field of view is limited by his helmet, and his range of vision depends on the depth at which he is working and the clarity of the water, which in turn depends largely on the nature of the bottom. His radius of action is limited by the scope of his air-pipe and breast-rope, and the necessity for keeping them clear of any submerged obstructions. His mobility and activity are much restricted by the water ; he cannot, for example, use a hammer and chisel with any appreciable effect, and so uses a hacksaw for cutting when possible.

In a standard diving dress a diver can work in depths of up to 180 feet without special equipment, but beyond this depth he requires special apparatus. He cannot work efficiently in a current or tidal stream of over one knot, so in tidal waters diving is usually carried out at slack water. A heavy swell is dangerous because of its undertow. Diving should not be carried out from a boat in rough weather, or when there is a possibility of the boat dragging her anchor. Diving from a boat should be suspended in fog or low visibility, because of the possibility of the boat being run down by another vessel.

AIR-PUMPS.

Portable, two-cylinder, air-pumps are supplied to H.M. ships for diving ; they can be adjusted to work on one or both cylinders, and are operated by turning handwheels fitted to each side of the pumps, the crank handle of each wheel being long enough for three men to man it. To supply air to a diver in depths of up to 33 feet requires one cylinder ; two are required in depths of from 34 to 99 feet, and three or four (necessitating two pumps) for depths of from 100 to 180 feet.

Prolonged diving in depths of over 78 feet requires three men on each handle of the pump and entails hard work on their part ; at least one relief pumping party should therefore be provided for such diving.

If a diver is employed on hazardous work, such as examining wrecks where there is a risk of him getting jammed or of his lines being fouled, another diver must be dressed and kept ready to go immediately to his assistance. As an air supply for the second diver must be available at a moment's notice, air-pumps should be provided on the following scale :—

in depths of up to $5\frac{1}{2}$ fathoms—	1 pump ;
in depths of from $5\frac{1}{2}$ to $16\frac{1}{2}$ fathoms—	2 pumps ;
in depths of from $16\frac{1}{2}$ to 30 fathoms—	4 pumps.

TO RIG A DIVING BOAT

The largest available boat suitable for carrying and working the pump (or pumps) and diving gear should be selected. The divers are usually dressed and attended in the sternsheets, and the pump should therefore be securely lashed amidships in the boat, with its gauges facing aft and with sufficient space each side of it for effectively manning the crank handles.

The boat is usually anchored, preferably moored head and stern between two anchors, while diving is being carried out. If the divers have to search for the object to be recovered two small buoys with sinkers and buoy ropes should be provided.

In addition to her normal gear the boat should carry two complete sets of diving dress and their associated equipment, two shot-ropes with sinkers and distance lines, two heaving lines, a watch, a red flag, the diving ladder with its chock and lashing, and the *Diving Manual* and the *Diving Record Book*. The diving ladder, which is made of iron and about 6 feet long, hooks over a special chock fitted on the gunwale of the boat and is lashed in place; the chock ensures that the weight of the diver on the ladder is evenly distributed along the gunwale. The diving flag should always be prominently displayed in the boat when diving is in progress; if diving is carried out alongside a ship a red triangular flag should also be displayed by the ship, at her appropriate yard arm.

SHALLOW-WATER DIVING

Small ships do not usually carry qualified divers or standard diving equipment, but they are provided with shallow-water diving dresses and their complement includes men trained in its use. A man rigged in one of these dresses can work in depths of up to 40 feet if he is supplied with air from an air pump, and he can work in depths of up to 33 feet if using a "Salvus" breathing apparatus rigged for diving (for a description of the "Salvus" apparatus, see page 56).

Shallow-water diving should always be carried out from a boat and never from the ship, and whenever a diver is down another diver should be ready at a moment's notice to go to his assistance. The diver is lowered and raised on a 3-inch life-line, marked at 10, 20, 30, 33 and 40 feet, which is secured round his body under his arms with a bowline; the first (10-ft.) mark should be 15 feet from the end of the line to allow for the bowline, and the last two marks should be of red bunting. The diver is also provided with a 3-inch shot-rope which has a 1½-inch distance line, 5 fathoms long, spliced into it. Two complete sets of diving equipment should always be carried in the diving boat, and they should be made up at the first opportunity after commissioning and set aside for use when required.

PRECAUTIONS

When using either the shallow-water, or the standard, dress and equipment the diver should never be dressed before the boat is properly anchored or secured in position; owing to the weight and clumsiness of his dress a diver may easily fall overboard, and even if only partially dressed he would sink immediately.

When a diver is sent to work on, or examine, a ship's underwater fitting a bottom line should be rove at the relevant station and tended by a responsible man during the whole time the diver is down; it takes the place of the shot-rope for guiding him to the position. Before descending the diver should be given detailed information regarding the position of the fitting, and its nature and appearance. To assist him to locate the fitting the inner side of the hull plating abreast it should be tapped continuously with a hammer from the time he starts his descent until he locates it. If work is to be done on a ship's propeller the Engineer Officer must be informed beforehand, the propeller shaft should be disconnected from the main engines, and the hand turning gear engaged; this prevents the propeller from being turned accidentally and also enables the propeller to be turned to the position required by the diver. Work on ships' propellers when using the shallow-water diving dress is classified as "hazardous".

Arming Boats

Boats are not fitted nowadays with mountings for small guns, but they may be equipped with small arms and ammunition as and when required. In open boats small arms are usually slung in beackets below the thwarts ; if not required for immediate use their breeches should be wrapped in cloth and their muzzles plugged to protect them from the weather.

REPAIR OF BOATS

When a boat's hull is damaged the damage is made good by effecting emergency, temporary, or permanent repairs, according to the time and facilities available. Any seaman should be able to effect a minor emergency repair, and though a temporary repair is actually a shipwright's job it should not be beyond the capability of a resourceful and experienced seaman, but a permanent repair is essentially a task for a shipwright.

Where possible a boat should be beached or hoisted inboard for repairs, but if the gunwales, sternpost, stem, or keel have been damaged, the boat should be surveyed by a shipwright before she is hoisted because it is on these main members of her hull structure that the slinging of the boat depends.

To make an Emergency Repair. Cut a patch of two thicknesses of canvas, or a piece of corticene, to a size sufficient to cover the hole or the area of damage with a three-inch overlap all round ; three-ply wood may also be used, but it is not as flexible as canvas or corticene and so will not follow the contour of the hull so closely. Well coat the inner side of the patch with tallow, place it on the outside of the hull so as to cover the damage, and tack down its edges, starting from the centre of each edge and working outwards while stretching the patch as much as possible. The tacks should be about three-quarters-of-an-inch from the edge and about half-an-inch apart. If the tacks penetrate the inner side of the planking their points should be hammered over with a light hammer in the direction of the grain of the wood while holding a heavy hammer over the head of the tack as support. This method of fastening can also be used with copper nails instead of tacks as a rough alternative to clenching where the fastenings have been damaged or have sprung.

If available a good thick coat of paint should then be applied over the patch, and over the points of the tacks on the inside of the hull.

If time and materials are available a copper tingle should be fitted over the patch, as described below.

To make a Temporary Repair of a Small Hole. A small hole or split plank should be repaired by fitting a copper tingle over it. First dress back any protruding ragged ends and fastenings, then measure the size of patch required and prepare a piece of fearnought large enough to overlap the damage by about 4 inches all round ; well coat one side of the fearnought with a mixture of equal parts of tallow and white lead, stretch it over the damage and secure its edges temporarily with a few copper tacks (see Fig. 224).

Now cut a sheet of thin (12-oz.) copper so that it will lap the damage by 3 inches all round, and with a fine bradawl or wire nail punch small holes round the edges, about half-an-inch apart and a quarter-of-an-inch from the edges, to receive the tacks for securing it. Then hang the tingle in position by tacking it at the centre of its top edge, dress out any puckers in the copper by means of a beechwood wedge, and complete the tacking of the top edge by working from the

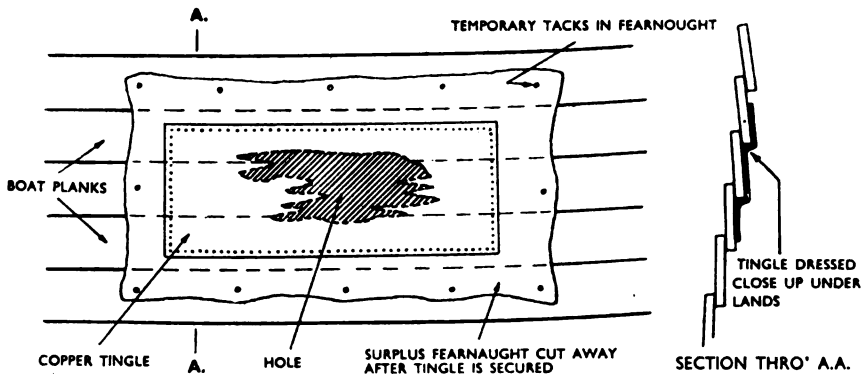


Fig. 224. Temporary repair with a tingle

centre outwards. In clinker-built boats very careful dressing is needed to fit the tingle tight up under the lands of the planking before tacking it in place. Superfluous fearnought outside the tingle should then be cut away, the heads of the tacks be smeared with a tallow and white-lead mixture, and the edges of the copper tingle be dressed close home to the hull with a light hammer. Then finish it by wiping off superfluous stopping and applying a thick coat of paint.

For more extensive damage, a hole 9 inches in diameter or larger for example, some form of doubling and perhaps stiffening to take the place of the missing sections of planking and timbers will be required for supporting the tingle. The simplest method of fitting this support is described below and illustrated in Fig. 225.

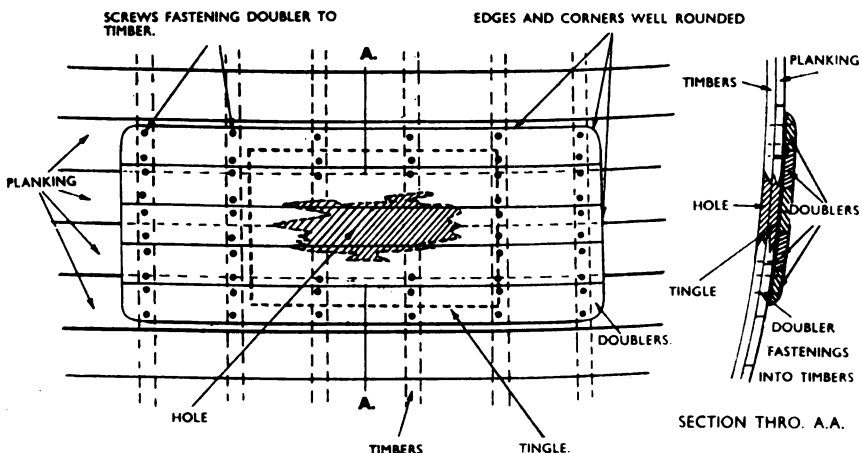


Fig. 225. Temporary repair with a tingle and doublers

First mark around the hole the centre lines of the timbers which will be required to take the fastenings of the doubling pieces, and then tack on the copper tingle as before. Then prepare a number of doubling pieces, from soft wood which is free of knots and about 3 inches wide by $\frac{5}{8}$ inches thick and long enough to lap the damage by at least two timber spaces, thus enabling the doublers to be secured to the timbers. For clinker-built boats the width of these doublers will have to be the same as the width of the planks less the land.

Assuming that the patch is for a carvel-built boat, hold the first doubler flush with the top edge of the tingle, mark the lines of the timbers on it, and then bore two holes on these lines and countersink them to take fine gauge screws for securing them to the timbers; next bore corresponding holes into but not through the timbers, and, having first coated the lower edges of the doubler with white lead, screw it in place. Try the next doubler in place, planing its edge as necessary to ensure a reasonable fit, and secure it as before; then continue fitting doublers until the whole of the copper patch is covered.

Finally, well round-off the edges and corners of the doubled patch to prevent it fouling any obstruction when the boat is alongside, plane off any inequalities in its thickness, see that all seams and edges are well stopped with white lead, and apply two coats of thick paint.

To make a Semi-permanent Repair of a Large Hole. For a large hole some form of stiffening must be introduced inside the boat, to provide a backing to which to fasten the doublers and to reinforce the planking around the hole.

First trim off any ragged ends of planking, timbers, and protruding fastenings inside the boat, so that the stiffening can be fitted closely to the edges of the hole, and then fit the copper tingle as before.

Prepare the stiffener from a piece, or pieces, of three-ply so that it is the right length to fit snugly between the timbers, and wide enough to cover the hole with an overlap of about 6 inches on sound hull planking above and below the damage. The stiffener can easily be bent to the shape of the hull with a light shore, about $1\frac{1}{2}$ inches square, set up from some portion of the boat's structure.

Now bore holes in the stiffener, the planking, the copper tingle and the doublers, as required to take the screws for securing the stiffener into sound hull planking above and below the hole and into the doublers, but taking care not to drill right through the planking where it is not backed by doublers, or through the doublers, and taking care to use screws which are not long enough to penetrate through them.

Repeat this in as many frame spaces as necessary, and it will be found that an efficiently fitted patch of this nature will last until a permanent repair can be undertaken by the repair ship or dockyard.

BUOYANCY OF BOATS

All pulling and sailing boats should be sufficiently buoyant when swamped to support a weight equal to at least one-tenth of the total weight of the boat and her complete equipment without sinking. If a pulling or sailing boat will not float under these conditions, sufficient empty barricoes or petrol cans to give her the necessary buoyancy should be kept secured to the underside of her thwarts until the first opportunity occurs to fit permanent metal buoyancy tanks, care being taken to place them so that the boat will still be correctly trimmed.

TESTING A BOAT FOR BUOYANCY

Before being put in the water the boat is weighed with all her equipment in place, except the strongback and purchase slings, and with her barricoes filled with water. She is then lowered into the water, her falls are left hooked on but slack, and the plug is then withdrawn. When the level of the water is the same inside the boat as outside her, ballast is lowered into the boat, and so

distributed as to keep her on an even keel, until the boat is in a sinking condition. Should the weight of this ballast be less than one-tenth of the total weight of the boat and her equipment extra buoyancy must be provided as described above.

All pulling and sailing boats should be tested for buoyancy every two years, the dates of all such tests being recorded on the boat, alongside her number. An example of a buoyancy test is given below.

BUOYANCY TEST OF A 32-FT CUTTER

	tons	cwt.	qr.	lb.
Weight of boat complete with equipment ...	2	6	1	10
Required positive buoyancy of 10 per cent. of the above weight		4	2	15
Weight of ballast required to submerge boat ...		2	2	3
Difference to be eliminated by fitting empty barricoes, cans, or buoyancy tanks		2	0	12

To find the volume in cubic feet of the extra buoyancy fittings required, this difference must be converted to pounds and divided by 64; the weight of one cubic foot of sea water being 64 lb.

2 cwt. and 12 lb. = 236 lb., which divided by 64 gives (approximately) 4 cubic feet, but in practice a safe margin above this figure should be provided for.

ESTIMATION OF BUOYANCY

Buoyancy of an Open Boat (see Fig. 226). The approximate weight in tons which an open boat can carry at any particular freeboard can be calculated from the formula :

$$W = \frac{(F_1 - F_2) \times L \times B \times c}{35} \text{ tons,}$$

in which

F_1 is the normal freeboard of the boat in feet at light-load draught ;

F_2 is the minimum freeboard in feet which is required at deep-load draught ;

L and B are, respectively, her inside length and breadth in feet at her mean draught between L.W.L. and D.W.L. ;

c is the co-efficient of fineness of her water plane area at her mean draught.

The co-efficient of fineness can be taken as being 0.65 for a cutter, and 0.6 for a whaler or a merchant ship's life-boat.

The number of men corresponding to this weight can be ascertained by multiplying it by 14, on the assumption that 14 average men weigh one ton.

The tons per inch immersion of a 27-ft. whaler is 0.25, and of a 32-ft. cutter it is 0.38 at 1-ft. 6½-in. draught, and 0.462 at 2-ft. 2¾-in. draught.

The only ballast allowed in Service pulling and sailing boats is water in casks or barricoes ; pig-iron, lead and other such forms of "dead" ballast are prohibited.

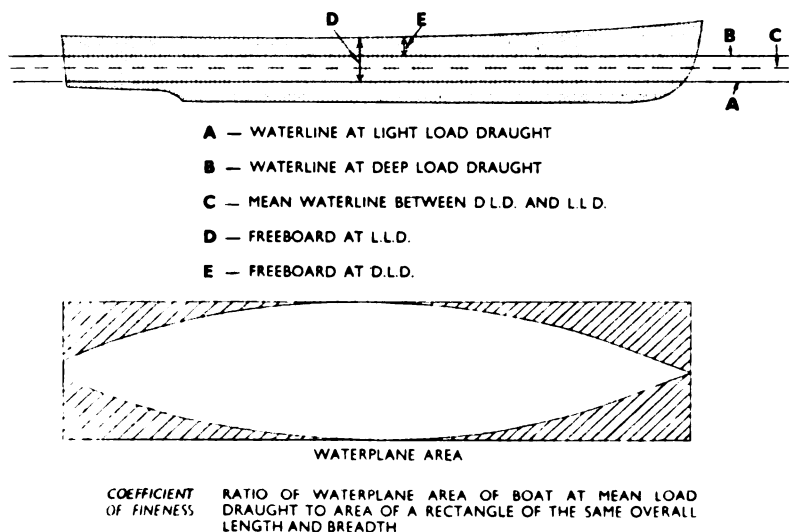


Fig. 226. Estimation of a boat's buoyancy

Buoyancy of Drums or Casks. The safe buoyancy of a drum or cask can be found from the following formulae :—

(i) when the cubic content is known :—

$$\text{safe buoyancy} = 9 \times c \text{ lb.,}$$

where c = the cubic contents in gallons ;

(ii) when the cubic contents are not known :—

$$\text{actual buoyancy} = 5 c^2 L - W \text{ lb.,}$$

$$\text{safe buoyancy} = 9/10 (5 c^2 L - W) \text{ lb.,}$$

where c = mean circumference of cask in feet,

L = internal length of cask in feet, and

W = weight of empty cask in lb.

SUPPLY, FITTING OUT, AND SPECIFICATIONS OF SERVICE BOATS

When a ship's boat is supplied by the Naval Store Officer of a dockyard she is provided with only those items of hull equipment and rigging which are peculiar to that type of boat. When received by the ship she must be equipped for sea service with standard naval stores, the quantity and type depending on the type of the boat and the purposes for which she is to be used. She must also be fitted with her slings.

Supply of Pulling and Sailing Boats

A pulling and sailing boat is supplied with all hull fixtures, masts and spars, sails, sail covers, rigging, and portable equipment such as the rudder, tillers, yoke and yoke-lines, stretchers and their fittings, bottom boards and gratings and their latches, towing bollard, extra thwart (cutters only), poppets (cutters only), main sheet horse (cutters only), strongback (launches, pinnaces, cutters and whalers), roller on transom (cutters only), ensign and pendant staves, bearing-out spars, awning with battens (only to Home Fleet ships and ships to proceed on service to hot climates), and painter.

The masts, spars, sails, rigging and portable hull equipment are listed on a typed sheet of foolscap called the *Boat's Equipment List*, and this list together

with the equipment listed on it should accompany the boat whenever she is transferred, or returned to store. A list of rigging items for a cutter, a whaler, a 27-ft. surf boat and a 14-ft. dinghy is given on page 347.

Supply of Power Boats

A power boat is supplied with all hull fittings and portable hull equipment such as a signal mast, cleats, bollards, awnings and their covers, stanchions, canopies, curtains, cushions, furniture, ladders, and brackets and screens for navigation lights. These are listed in a printed pamphlet called the *Boat's Fixture List*, and are taken on charge by the Shipwright Officer. This list and the equipment listed in it should accompany the boat whenever she is transferred, or returned to store. Details of any rigging supplied with the boat are included in the *Ship's Rigging Warrant*.

A power boat is also provided with an *Engineer's Spare Gear List* (Form D. 320B), which gives the details of the engines with which the boat is fitted. Two lists of spare gear are provided for each engine, one is held by the Naval Store Officer of the dockyard and the other by the Engineer Officer of the ship; the latter list should accompany the engine whenever it is removed from the boat and transferred ashore or to another ship.

Fitting out Pulling, Sailing and Power Boats

When the boat is drawn from store it must be fitted out in the ship with Naval stores to the scales shown in the tables on pages 348 and 349, and with the following miscellaneous Naval stores :—

- a bailer ;
- barricoes (four 6-gallon for cutters, whalers and 27-ft. surf boats) ;
- a boat's cover ;
- boat-hooks ;
- a canvas bucket ;
- a cable punch (if fitted with chain cable) ;
- a compass and binnacle ;
- cradles for barricoes (if barricoes are not slung below the thwarts) ;
- crutches and oars ;
- an ensign and pendant ;
- fenders ;
- fire extinguishers (if a power boat or a pulling boat fitted with an auxiliary motor) on the scale given in B.R. 321—*Engineering Establishment* ;
- a Klaxon horn (if a power boat not otherwise equipped for sound signalling) ;
- a funnel, 3 quart size (if a power boat) ;
- an oil lantern (or a candle lantern and candles if a pulling or sailing boat) ;
- navigation lanterns (if a power boat, or a pulling boat fitted with an auxiliary motor)—*i.e.* a starboard lantern and a port lantern (or a combined port and starboard lantern) a steaming lantern, and an overtaking lantern ;
- a boat's lead and line ;
- life-jackets (one for each member of the crew and one spare) ;
- a life-buoy (only if a power boat) ;
- a reel for boat's cable (if a cable locker is not provided) ;
- lumber crutches (for launches, pinnaces and 27-ft. surf boats only) ;
- a reel for a small wire hawser (launches and pinnaces only) ;
- a copy of the *Boat's Signal Book*, a hand answering pendant, and a pair of hand semaphore flags ;

signal flags and a wallet (if a power boat equipped with a signal mast) ; a boat's bag, a carpenter's bag, and a boat's distress signal box (for contents see Volume I of this Manual, page 190).

FITTING SLINGS TO BOATS

When any boat is supplied to a ship she is fitted, by a shipwright on the staff of the Foreman of Boats of the dockyard, with her sling bolts or plates if not already in place and with the slings peculiar to her type and the method by which she will be hoisted and lowered. Details of the slings for every ship's boats are given in the *Rigging Warrant*. Boats hoisted at davits are provided, at the same time that the slings are fitted, with a Robinson's patent hook, and if seaboats they are then equipped with Robinson's patent disengaging gear.

SAILING GEAR FOR BOATS

	CUTTER	WHALER	27-FOOT SURF BOAT	DINGHY
Sails				
Foresail	1	1	1	1
Mainsail	1	1	1	1 (with battens)
Mizzen	—	1	—	—
Genoa Jib	—	—	1	—
Storm trysail	1	1	1	—
Storm foresail	1	1	1	—
Masts and Spars				
Masts	1	2	1	1
Yards	1	1	—	—
Gaffs	—	—	1	1
Booms	—	1 (mizzen)	1	1 (roller reefing)
Bearing-out spars	2	2	—	—
Standing Rigging				
Shrouds	2	2	2	2
Forestay	1	1	1	1
Backstays	2 (with runner tackles)	—	—	—
Running Rigging				
Halyards—fore	1	1	1 (with mast- head pendant and block)	1
—main	1	1	1	2 (Throat and peak) 1 pair
Sheets —fore	1 pair (with lizard bullseyes)	1 pair	1 pair	—
—main	1	1 pair	1	1
—mizzen	—	(complete with blocks and/or bullseyes) 1 (with leading block)	—	—
—trysail	—	—	1	—
Topping Lifts	1	1 (mizzen)	—	—
Brails	1 pair	1 pair	—	—
Tack-tackle	1	1	1	1
Centre-board tackle	1	1	1	1 (winch rope)

PARTICULARS OF SERVICE

The numbers in the last column represent the normal carrying capacity of each boat in calm weather. The numbers should be reduced at the discretion of the Officer of the Watch, or of the person in charge of the boat, according to the weather and the nature of the duties to be performed. In exceptional circumstances, such as "abandoning ship" in calm weather, the normal carrying

TYPE OF BOAT	BREADTH EX- TREME ex rubbers	RIG AND IDENTI- FICA- TION SYMBOL	SAILS							
			DIMENSIONS (fully stretched)						AREA	NO. OF REEFS
				Head	Foot	Luff	Leach	Diag.		
Pulling and Sailing Boats	<i>ft. in.</i>			<i>ft. in.</i>	<i>ft. in.</i>	<i>ft. in.</i>	<i>ft. in.</i>	<i>ft. in.</i>	<i>sq. ft.</i>	
32-FT. SAILING CUTTER ... (drop keel)	8 6½	Sloop D Z	Fore Main Storm F. Storm M.	— 20 4 — —	10 0 18 6 6 6 17 0	18 3 8 4 11 0 17 0	14 6 30 3 7 9 21 4	— 19 8 — —	79 299 27 154	2 2 3 —
27-FT. WHALER (drop keel)	6 0	Yaw K	Fore Main Mizzen Storm M.	— 14 4 — —	6 3 12 6 6 9 12 0	11 3 6 6 6 9 11 3	9 8 2 2 10 0 15 0	— 2 13 10 0 —	33 148 32 71	1 3 — —
27-FT. SURF BOAT (drop keel) (Surveying Vessels)	6 1½	Gunter	Fore Main Storm F. Storm M.	— 12 8 — —	8 0 12 9 5 9 12 3	16 6 9 6 13 0 14 6	13 6 22 6 9 0 18 7	— — — —	56 154 22 88	1 2 — 1
14½-FT. SURF BOAT (drop keel) (Surveying Vessels)	5 0	Lug- sail	Main	10 6	9 3	4 10	16 3	—	70	2
14-FT. SAILING DINGHY ... (drop keel)	5 4½	Gunter R N	Fore Main	— 14 6	5 2 10 1	12 3 5 4	11 1 21 2	— 10 11	29 108	1 (roller)
10-FT. SAILING DINGHY ... (Yacht type with dagger plate)	4 3	Stand. Lug- sail	(some boats are not provided with sailing gear)							
			Main	9 0	7 0	3 0	11 8	—	50	—

Pulling Boats

17½-FT. BOOM BOAT ... (Boom Defence Vessels)	7 3	No sailing gear provided								
16-FT. TRAWLER BOAT ... (Trawlers)	5 9	Boat was not designed for sailing, but in certain circumstances may be provided with sailing gear, or with an outboard motor.								
14½-FT. DRIFTER BOAT ... (Drifters)	5 9	No sailing gear provided, but in certain circumstances may be provided with an outboard motor.								
COLLAPSIBLE DINGHIES										
12-ft.	4 6½	Dimensions folded :—12 ft. × 3 ft. × 1 ft. 4 in. 10 ft. × 2 ft. 10 in. × 1 ft. 10 in.								
10-ft.	4 1½									

PULLING AND SAILING BOATS

capacity may be exceeded, but this must be left to the discretion of whoever is in charge of the boat. The weight in tons which can be carried in each type of boat can be calculated by dividing her carrying capacity by 14 (on the assumption that the average man weighs 160 lbs.), but it is emphasised that if cargo is carried instead of men it must be carried as low in the boat as possible and on no account athwart or above the gunwales.

MAST AND SPARS (dimensions of yards are given from the inner edges of the holes at throat and peak)				GROUND TACKLE							PAINTER	OARS	LIFTING WEIGHT (incl. 2 men)	CARRYING CAPACITY
				AN-CHOR	CABLE									
					MAST		SPARS			MANILA		CHAIN			MANILA
Length	Diam.	Length	Diam.	A.P.	Size Lgth.		Size Lgth.		Size Lgth.			No. Lgth.		
ft. in. 23 2 5		Yard 20 6 3½		lb. 40	in. 3	fm. 25	in. ½	fm. 5	in. 3½	fm. 8	8 15 4 14	cwt. 52	men 29	
Main 16 6 3½ Mizn. 13 6 2½		Yard 14 5½ 2½ Boom 6 10 2		30	2½	20	½	5	3	7	4 17 1 16	26	15	
20 10 (hollow)	3 ½	Gaff 12 8 2½ (hollow) Boom 14 0 2½ (solid)		20	2	50	—	—	3	7	2* 17 5 14½ 4 13½ 10†† 11½	28	15	
12 0 2½		Gaff 11 0 2½ Boom 10 0 2½		20	1½	30	—	—	2½	4	1* 9 4†† 9 2†† 8	10	7	
14 6 3		Gaff 15 0 2½ Boom 10 8 2½		20 (Dirigo)	2	20	—	—	2	4	4 8	10	6	
9 6 2½		Yard 9 6 2½		10 (Dirigo)	1½	20	—	—	1½	3	2 7½	4†	3	
				30	2½	25	½	3	3	5	2 8 4 10 2 14	45**	13	
				20	2	20	—	—	2½	4	2 10 2 14	16	8	
				20	2	20	—	—	2	4	2 10 2 14	10	7	
									2 3 2 3		2 8½ 2 8½	5† 4†	4 2	

* Steering oars

† Includes one man only

** Includes special equipment

†† Surf oars

PARTICULARS OF SERVICE

The numbers in the penultimate column represent the normal carrying capacity of each boat in calm weather. The numbers should be reduced at the discretion of the Officer of the Watch, or of the person in charge of the boat, according to the weather and the nature of the duties to be performed. In exceptional circumstances, such as "abandoning ship" in calm weather, the normal carrying capacity may be ex-

TYPE OF BOAT	BREADTH EXTREME ex rubbers	SPEED (approx.)	B.H.P. (approx.)	GROUND TACKLE					
				ANCHOR		CABLE			
				A.P. C.Q.R.		MANILA		CHAIN	
				lb.	lb.	Size	Lgth.	Size	Lgth.
	ft. in.	knots				in.	fm.	in.	fm.
Round-Bilge (slow type)									
45-ft. DIESEL PICKET BOAT ...	10 6	13	170	—	53	3	35	$\frac{1}{8}$	8*
45-ft. MOTOR LAUNCH	11 6	8	35	—	72	3 $\frac{1}{2}$	35	$\frac{1}{2}$	8*
36-ft. MOTOR AND PULLING PINNACE ...	9 9	7 $\frac{1}{2}$	20	—	53	3	35	$\frac{1}{8}$	5
35-ft. MOTOR BOAT† ...	7 8	8	36	50	—	—	—	$\frac{1}{8}$	40
32-ft. MOTOR CUTTER ...	8 6 $\frac{1}{2}$	7 $\frac{1}{2}$	20	—	26	3	35	$\frac{1}{8}$	5
30-ft. MOTOR PINNACE†	7 6	7 $\frac{1}{2}$	20	40	—	—	—	$\frac{1}{8}$	40
27-ft. MOTOR SEABOAT	7 2 $\frac{1}{2}$	7	20	—	26	2 $\frac{1}{2}$	25	$\frac{1}{2}$	3
25-ft. MOTOR CUTTER...	7 0 $\frac{1}{2}$	6-7	10	—	26	2 $\frac{1}{2}$	25	$\frac{1}{2}$	3
25-ft. MOTOR BOAT (1950)† ...	8 0	11-12	65	—	26	2 $\frac{1}{2}$	25	$\frac{1}{2}$	5
20-ft. MOTOR BOAT ...	6 0	6-7	10	30	—	—	—	$\frac{1}{8}$	15
16-ft. MOTOR BOAT ...	5 7 $\frac{1}{2}$	6	7	—	15	2	20	—	—
13 $\frac{1}{2}$ -ft. MOTOR DINGHY	4 11	5	5	20	—	2	20	—	—
Hard-Chine (fast type)									
45-ft. MOTOR BOAT† ...	10 6 $\frac{1}{2}$	16	195	—	41	2 $\frac{1}{2}$	25	$\frac{1}{2}$	8*
35-ft. MOTOR BOAT† ...	8 10 $\frac{1}{2}$	16-18	130	—	26	2 $\frac{1}{2}$	25	$\frac{1}{2}$	5
30-ft. MOTOR BOAT† ...	8 0	13-16	95	—	26	2 $\frac{1}{2}$	25	$\frac{1}{2}$	5
25-ft. MOTOR BOAT† ...	7 0	12-14	65	—	26	2 $\frac{1}{2}$	25	$\frac{1}{2}$	3
16-ft. MOTOR DINGHY	5 6 $\frac{1}{2}$	17-21	50	—	15	2	20	—	—
Round-Bilge (for Surveying Service)									
29-ft. MOTOR BOAT ...	8 0	8	45	50 or 53	—	—	—	$\frac{3}{8}$	30
28-ft. MOTOR BOAT ...	7 6	7 $\frac{1}{2}$	25	50 or 53	—	—	—	$\frac{3}{8}$	30
25-ft. MOTOR BOAT ...	6 8 $\frac{1}{2}$	7 $\frac{1}{2}$	22	30	—	—	—	$\frac{3}{8}$	25
16-ft. MOTOR BOAT ...	5 5	6	7	—	15	2	25	—	—
Landing Craft (flat bottomed)									
36-ft. L.C.P. (L.) ...	10 6	10	160	2 Duerr. 45 and 54	3	35	on each anchor	$\frac{3}{8}$	5

† These boats may be equipped as Flag Officers' barges.

* Comprises 3 fathoms at inner end and 5 fathoms at outer end.

POWER BOATS

ceeded, but this must be left to the discretion of whoever is in charge of the boat. The weight in tons which can be carried in each type of boat can be calculated by dividing her carrying capacity by 14 (on the assumption that the average man weighs 160 lbs.), but it is emphasised that if cargo is carried instead of men it must be carried as low in the boat as possible and on no account on the deck of the boat.

PAINTER		BARRICOES		LIFTING WEIGHT	CARRYING CAPACITY	SERVICE AND REMARKS
MANILA				including 2 men	(see note above)	
Size	Lgth.	No.	Size			
in.	fm.		galls.	cwt.	men	
3	11	6	10	190	60	Battleships
3½	11	6	10	180	105	Battleships and large Repair Ships
3	9	6	10	130	52	Cruisers and above
3	9	4	6	110	40	Cruisers and above
3	8	4	6	80	31	Cruisers and above
3	8	4	6	92	30	Cruisers
2½	7	4	6	65	26	Cruisers and above
2½	7	4	6	46	26	Cruisers and Destroyers
2½	7	4	6	65	30	Destroyers and above
2	5	2	6	38	12	Auxiliary Vessels
2	4	—	—	22	8	Minor War Vessels
2	3	—	—	14	5	Submarines
2½	11	6	10	172	88	Battleships (obsolescent)
2½	9	4	6	100	50	Cruisers and above
2½	8	4	6	70	35	Light Cruisers and for special duties in large ships
2½	7	4	6	50	21	Generally all ships, and particularly Destroyers and Sloops
2	4	—	—	25	7	Generally all ships, and particularly Destroyers and Sloops
3	8	4	6	102	20	
3	7	4	6	102	20	
2½	7	4	6	66	20	
2	4	—	—	20	7	
3	9	4	6	—	50	Large ships

PARTICULARS OF SERVICE FLOATS, RAFTS, ETC.

TYPE	LGTH.	BDTH.	OARS OR	PAINTER		LIFT- ING WT.	CAPA- CITY	REMARKS
			PADDLES	MANILA				
			No. Lgth.	Size Lgth.				
Copper Punts (2 sizes)	<i>ft.</i> 13½	<i>ft. in.</i> 5 2	<i>ft.</i> 2 8½	<i>in.</i> 1½	<i>fm.</i> 2	<i>lb.</i> 896	<i>men</i> 6	For use of Side Party
	10	4 6	2 8½	1½	2	672	4	
Carley Floats (2 sizes)	8	5 0	6 paddles	2½	6	300	18	Pattern No. 19
	10	5 0	6 paddles	2½	6	385	20	Pattern No. 20
Box Float	3	3 0	— —	1½	3	70	8	Made of expanded rubber covered with plywood
Inflatable Life-rafts (2 sizes)	16	10 0	Size packed :— 4 ft. × 4 ft. × 2 ft.			350	20	Patt. No. 5600. Lifting wt. includes equipment.
	9 (diam.)		Size packed :— 3 ft. × 2 ft. × 1 ft. 6 in.			200	8	Patt. No. 5601. Lifting wt. includes equipment.

CARRYING CAPACITIES OF HARBOUR FERRY SERVICE CRAFT

Note : Attention is drawn to the note at the head of pages 350 and 351. The numbers shown below are to be reduced at the discretion of the person in charge of the boat with due regard to the weather and other circumstances.

TYPE OF BOAT	NORMAL CARRYING CAPACITY
90-ft. Motor Fishing Vessel	300
75-ft. Motor Fishing Vessel	200
61½-ft. Motor Fishing Vessel	150
45-ft. Motor Fishing Vessel	100
52½-ft. Harbour Service Launch	90
45-ft. Motor Passenger Launch	67
45-ft. Medium-speed Picket Boat	60
36-ft. Harbour Launch.	52

CHAPTER VIII

Life-Saving Appliances and Rocket Life-Saving Apparatus

IN this chapter are described the various life-saving appliances and equipment provided in ships, and the "rocket life-saving apparatus" provided on shore for rescuing the crew of a stranded ship.

LIFE-SAVING APPLIANCES

In the Royal Navy the number and type of life-saving appliances supplied to each ship are determined by the Admiralty, and depend largely on the type of ship and the duties on which she is engaged.

In the Merchant Navy these appliances are supplied in accordance with the provisions of the *Merchant Shipping Act* and by the *Merchant Shipping (Life-saving Appliances) Rules, 1948*, and their number and type depend largely on whether or not the ship carries passengers and whether she is ocean-going or engaged on coastal or cross-channel trade.

CLASSIFICATION

Life-saving appliances in warships differ somewhat from those in merchant ships, but generally speaking are of four main categories as described below. -

- (i) *Life-jackets*. These are worn by individuals to support themselves in the water, a sufficient number being carried by merchant vessels to provide one for each person on board. Under this heading are also included the buoyant suits provided in H.M. ships.
- (ii) *Life-buoys*. If a man falls overboard a life-buoy is thrown to him for him to cling to until he can be rescued. The number carried depends upon the type and length of the ship and the trade in which she is engaged.
- (iii) *Buoyant apparatus*. This comprises all types of life-floats or life-rafts which are designed to support a number of persons in or on the water. In the Merchant Navy these supplement the ship's boats, and the number carried depends upon the number of boats with which the ship is equipped, and the number of persons she is certified to carry. In the Royal Navy the ship's boats are not regarded as life-boats because they are not constructed as such and because it may not be possible to launch them in emergency; sufficient buoyant apparatus is therefore provided for the full complement of each ship.
- (iv) *Life-boats*. These are specially constructed boats carried by merchant ships; they may be propelled by oars, sails or mechanical means, and each is rated to carry a specified number of persons. The number of such boats carried by a merchant ship depends upon the trade in which she is engaged and the number of persons she is certified to carry.

SPECIFICATION AND SURVEY

All life-saving appliances supplied to British merchant ships must be made in accordance with the specifications laid down by the Ministry of Transport,

and before supply they must pass specified tests. When installed in a ship they are usually inspected by a surveyor, appointed by the Ministry of Transport, to ensure that the ship carries her specified number of appliances in a correct manner and that each is of the required quality ; if the surveyor is satisfied he gives a certificate to that effect, on a *Form Surveys* 123, to the master or owner of the ship. Such a certificate remains valid for at least one year, but never for longer than two years, and it is renewable after a fresh inspection. A ship in service may be inspected by a surveyor at any time to ensure that her life-saving appliances and their launching arrangements are in good condition and correctly maintained, and if then satisfied he may renew her original certificate for a further period.

MARKING

All life-saving appliances in British merchant ships must be marked in the following manner to show that they fulfil the required standards :—

Life-jackets should be marked indelibly on one side with the distinctive name of the life-jacket in letters not less than one inch in depth, and on the other side with the maker's name or trade mark in smaller letters ; also with the surveyor's initials and date stamp.

Life-buoys do not carry standard markings other than the surveyor's date stamp, but they should be painted, preferably in two colours, say red and white or yellow, so that they may be distinguishable by day or by night. They may also be marked with the ship's name.

A *Buoyant Apparatus* should be marked " Buoyant Apparatus . . . Persons ", and the numbers denoting its designed capacity in persons should be cut or branded indelibly in its structure. In foreign-going passenger steamers the words " Foreign-going Ship " should be added to the marking after the words " Buoyant Apparatus ". The apparatus should also bear the Ministry of Transport mark, M  T, together with the initials of the surveyor and the date of survey.

A *Life-boat* should be marked with her dimensions, *i.e.* length, beam and draught, and with the number of persons she is designed to carry. She should also bear the Ministry of Transport mark, M  T, together with the initials of the surveyor and the date of survey. These marks should be cut or indelibly stamped on her stem or on the sheer strakes at her bows.

STOWAGE AND EQUIPMENT

The general rules for the stowage of life-boats and buoyant apparatus in British merchant ships are as follows :—

- (i) they must be capable of being put into the water safely and rapidly, even under unfavourable conditions of list and trim ;
- (ii) each must be capable of being put into the water without interfering with the lowering or dropping arrangements of the others ;
- (iii) it must be possible to embark the passengers in the boats rapidly, and in good order.

The equipment of life-saving appliances includes food and water, and such articles as torches, distress flares, first-aid kit, oars and sails. The quantity and type of equipment carried in any life-saving appliance depends upon the type of the appliance and the number of persons it is designed to support ; scales of equipment for appliances carried in British merchant ships are laid down by the Ministry of Transport, and those for appliances carried in H.M. ships are determined by the Admiralty.

Life-jackets and Buoyant Suits

FOR MERCHANT SHIPS

The life-jacket for use in merchant ships must fit round the body, be reversible so that it can be put on back to front, upside down or inside out, and be suitable for both adults and children. It must be capable of floating in fresh water for at least 24 hours with 16½ lb. of iron suspended from it, and it must then be capable of supporting 20 lb. of iron. The buoyancy of a life-jacket must not depend on air compartments or inflatable tubes, and most life-jackets are made of stout linen or cotton fabric sewn with pockets into which are placed slabs of solid cork or which are stuffed with kapok fibre.

Two life-jackets of designs approved by the Ministry of Transport are illustrated in Fig. 227(i) and (ii); the first is for the use of passengers, and the second, which is designed for wear when carrying out normal duties, is for the crew, and has a becket incorporated in it by which the wearer can be hoisted out of the water. In war life-jackets may be equipped with a light for attracting attention at night, and a whistle for attracting attention in low visibility; the light, which is battery operated and capable of burning continuously for 12 hours, is clipped to the shoulder and the battery is stowed in a pocket in the life-jacket.

Each life-jacket is inspected and tested for buoyancy at the factory before being issued for service; those in ships are inspected by surveyors at intervals of from one to two years, and a percentage of them may be then subjected to a buoyancy test. Life-jackets should be stowed in places free from damp and undue heat, and those filled with kapok should be kept out of sunlight. Life-jackets in daily use, such as those provided for the emergency life-boats, should be inspected at regular and frequent intervals. Life-jackets should never be painted because paint rots the fabric and its weight reduces the buoyancy of the jacket; they should be cleaned by lightly scrubbing them with soap and warm fresh water.

One life-jacket for each passenger or member of the crew must be carried; they are stowed in conspicuous places in the ship's quarters, and in the cabins and saloons of the passengers. At sea, in war, it is usual for the crew and passengers to wear or carry their life-jackets by day, and to have them near at hand at night.

When putting on a life-jacket it should be very firmly secured round the body by its tapes. It is not advisable to jump into the water from heights above 10 feet when wearing a life-jacket of the non-inflatable type, because on impact with the water the jacket may be forced violently upwards against the wearer's head and so knock him out or even break his neck. If jumping into the water is unavoidable the jacket should not be put on until in the water; or if this is impracticable, the arms should be crossed on the chest with the hands on the shoulders, thus holding down the jacket on impact with the water.

FOR H.M. SHIPS

The standard general-purpose life-jacket for use in the Royal Navy is illustrated in Fig. 227 (iii). It is made of stout canvas, and is sewn with pockets, into which are placed slabs of solid cork. It is then placed over the head, either way round, and secured round the body, by two tapes, one at the front and one at the back, as illustrated.

The remarks on inspection, testing, survey, maintenance and use of merchant ship's life-jackets apply in general to the standard life-jackets for H.M.



(i) Place the jacket over the head and pass the arms through the arm-holes in the manner illustrated.

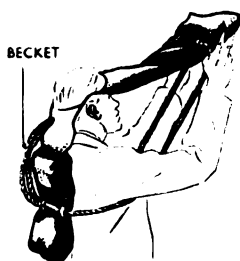


(ii) Take the tapes hanging down in front, and tie an overhand knot in them across the chest.



(iii) Draw the tapes well taut and complete the knot by tying a double bow.

(A) THE MINISTRY OF TRANSPORT STANDARD LIFE JACKET



(i) Place the jacket over the head with the rope under the arms in the manner illustrated. Note the rescue becket at the back.



(ii) Take the ends of the rope and tie them with an overhand knot over the front of the jacket.



(iii) Draw the knot well taut and complete it by tying a double bow.

(B) THE "VICTORY" LIFE JACKET



(i) Place the jacket over the head and pass the arms through the arm-holes in the manner illustrated.

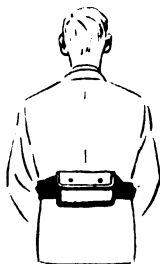


(ii) Take the tapes attached to the back of the jacket, and tie them tightly across the front of the jacket with a double bow between the two lower sections of the jacket.



(iii) Take the tapes attached to the front of the jacket and tie them tightly across the back of the jacket in a manner similar to (ii).

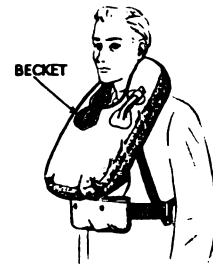
(C) THE STANDARD LIFE JACKET FOR H.M. SHIPS



(i) Life jacket in pouch worn in the small of the back.



(ii) Bring the pouch round to the front of the body, take out the bag and place it over the head.



(iii) Inflate the bag by blowing into its mouthpiece. Note the rescue becket.

(D) THE INFLATABLE LIFE JACKET FOR R.N. PERSONNEL

Fig. 227. Life-jackets

ships. One is provided for each member of the crews of the ship's boats, but in destroyers and larger ships the total number provided should not be less than 40.

In the Second World War each officer and man was issued, as part of his personal kit, with an inflatable life-belt, and it may still (1950) be provided for special service. It consists of a rubber tube fitted with a mouth-piece in which is incorporated a screw-down non-return air valve, and it is blown up by the wearer. The tube is covered with fabric and secured over the shoulders and round the body by tapes.

An inflatable life-jacket has been designed to replace the inflatable life-belt and is now (1950) undergoing trials. The prototype, which is illustrated in Fig. 227(iv), is made of two-ply, yellow, rubberised cotton fabric, and is shaped to fit round the neck of the wearer and rest on his chest; it is fitted with a mouthpiece and valve so that the wearer can inflate it. When deflated the jacket is stowed in a canvas pouch fitted to a webbing belt worn round the waist.

Buoyant Suit.—The "Escape Suit" is provided for crews of submarines instead of the life-jacket. It is an inflatable, overall suit, which covers the head and the body and is designed to support the wearer in the water and also to protect him from the elements. The suit is inflated by the mouth, and has a battery-operated electric light attached to the shoulder to indicate the wearer's position at night.

Life-buoys

A life-buoy may be of circular or horse-shoe shape; it should be made of solid cork, or some similar substance such as balsa wood, and covered with painted canvas; it must not be filled with rushes, cork shavings, granulated cork or other substances of a similar nature, and its buoyancy must not depend on air compartments or inflatable tubes. It should not weigh more than $13\frac{1}{2}$ lb. when new, and should be capable of floating in fresh water for at least 24 hours with 32 lb. of iron suspended from it.

The Kishie life-buoy, illustrated in Fig. 228, is the type usually provided in warships and merchant ships. It is fitted with a life-line which is seized to it in four places to form four easily grasped becketts; these should never be stopped together at the centre of the buoy as is sometimes done for the sake of appearances, because this will prevent a man passing his head and shoulders through the buoy.

A life-buoy may be fitted with a lanyard to which is attached either a buoyant calcium light, or a buoyant, battery-operated, self-igniting, electric light, the former capable of burning brightly for at least 40 minutes, and the latter for about eight hours. The calcium light consists of a canister filled with calcium carbide which ignites on contact with the water, burns with a bright yellow light while emitting white smoke, and so indicates the position of the buoy by day or by night. The plug of the canister should be secured by a lanyard to the guard rails or some other part of the ship's structure to ensure that it is automatically pulled out of the canister when the buoy is cast overboard. *The calcium light must never be used if there is any readily inflammable liquid such as petrol on the surface of the water*, and it may not be carried in petrol or oil tankers, or in British merchant ships using diesel oil or oil fuel.

Life-buoys should be inspected frequently and tested at regular intervals.

They should not have too many coats of paint as the weight of the paint will reduce their buoyancy.

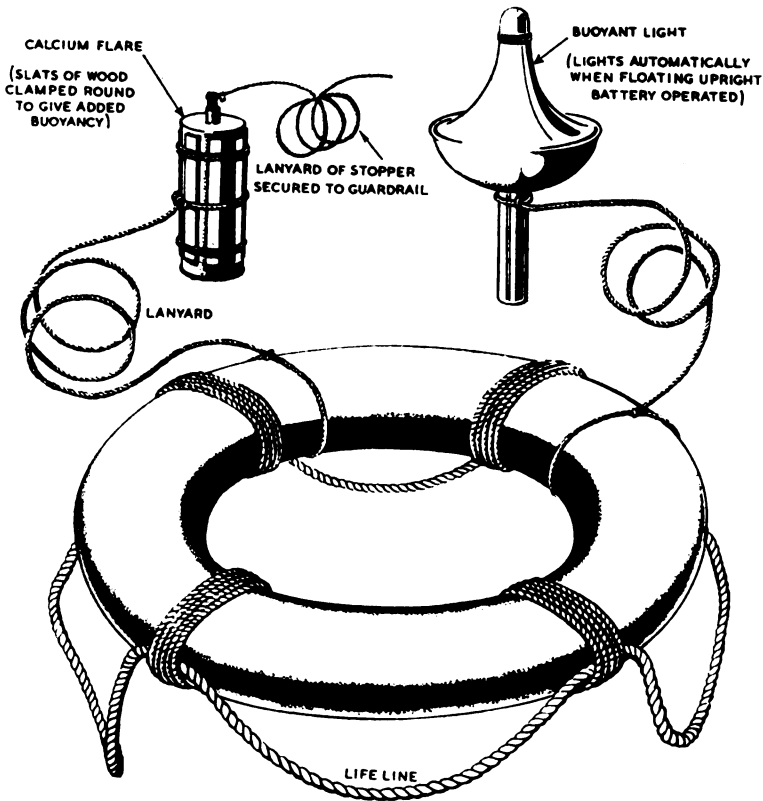


Fig. 228. Kisbie life-buoy fitted with lights

Life-buoys are hung in conspicuous and handy positions on the upper decks of ships, the number carried depending on the type of ship, her length and the duties or trade in which she is engaged.

H.M. Ships.—In cruisers and larger ships two of these buoys, are placed aft, one on each side of the ship, under the charge of a life-buoy sentry, and they are fitted with electric or calcium lights or both. In the vicinity is a telephone to the bridge, and an electric bell which is operated from the bridge in accordance with the following code :—

- one ring*—cast overboard the starboard life-buoy ;
- two rings*—cast overboard the port life-buoy ;
- three rings*—cast overboard both life-buoys.

In smaller ships a life-buoy fitted with a light is carried on each side of the bridge.

In *British merchant ships* a life-buoy, fitted with a self-igniting buoyant light attached to the buoy with a two-fathom lanyard, must be carried on each side of the navigating bridge in such a manner that it can be released instantaneously and dropped clear of the ship's side into the water.

The number of life-buoys carried by a British merchant ship depends on her length, whether she is a cargo or passenger ship or both, and whether she is an ocean-going ship or engaged only in coastal trade. For example : an ocean-going freighter not certified to carry passengers must carry at least six life-buoys ; an ocean going passenger ship carrying more than 12 passengers must carry life-buoys in accordance with the scale given below.

<i>Length of Ship</i>	<i>Minimum number of Life-buoys</i>
Under 200 feet 	8
Not under 200 feet, but under 400 feet ...	12
Not under 400 feet, but under 600 feet ...	18
Not under 600 feet, but under 800 feet ...	24
800 feet and over 	30

Similar scales are laid down for vessels such as excursion and cross-channel steamers, coastal vessels, and pleasure launches.

Half the number of life-buoys carried must be equipped with a buoyant self-igniting light, and one life-buoy on each side of the ship must be fitted with a 15-fathom life-line.

At the alarm " Man overboard " one or more life-buoys should immediately be thrown near the man, care being taken not to hit him. In a tide-way or when the ship is under way one of these buoys should be fitted with a light.

The simplest way to get into a circular life-buoy in the water is to place both hands on the side nearest to you ; your weight will then force this side down and lift the further side, thus enabling you to insert your head and shoulders. Then, resting your arms on the sides, you will find yourself supported with your head and shoulders clear of the water, and if you remain steady in such a position you can remain afloat for any length of time.

Buoyant Apparatus

Under this heading are included small floats, the Carley life-floats, the inflatable life-raft provided in H.M. ships, and also deck furniture such as buoyant seats and buoyant deck-chairs.

A buoyant seat is much like a garden seat for seating four to six people ; it is usually made of wood, and incorporates metal buoyancy tanks below the seat. A buoyant deck chair has its canvas seat sewn with pockets which are stuffed with kapok fibre. The number of persons for which any such apparatus is rated is the greatest whole number found by dividing by 32 the weight of iron in pounds which the apparatus will support in fresh water ; if, for example, a seat will support 150 lb. of iron in fresh water, it is rated for four persons.

Any buoyant apparatus provided in British merchant ships must float stably either side up, be light enough to be cast overboard from its stowage deck without suffering damage, must not depend for its buoyancy on inflation, must have a life-line securely becketed round the outside, and must be fitted with a painter.

CARLEY LIFE-FLOAT (Fig. 229)

This is now (1950) in general use as a life-float in warships and merchant ships, but it will probably be superseded in H.M. ships by the " inflatable life-raft " described on page 361. It is designed to float either side uppermost, and consists of a copper tube of large diameter, formed into an oval ring and

divided by bulkheads into water-tight compartments ; each compartment is fitted with an air valve to enable it to be air-tested for water-tightness. The tube is covered with a layer of cork parcelled with painted canvas, a platform of slatted wood is slung from the inner edge of the tube by rope netting, and a life-line fitted with wooden or cork floats is becketed round the outer edge of the tube. The float is fitted with a painter, a buoyant light, a wooden box containing water in tins and emergency equipment, and a set of wooden paddles is provided which should be secured at intervals to the tube by lanyards rove through holes drilled through their grips.

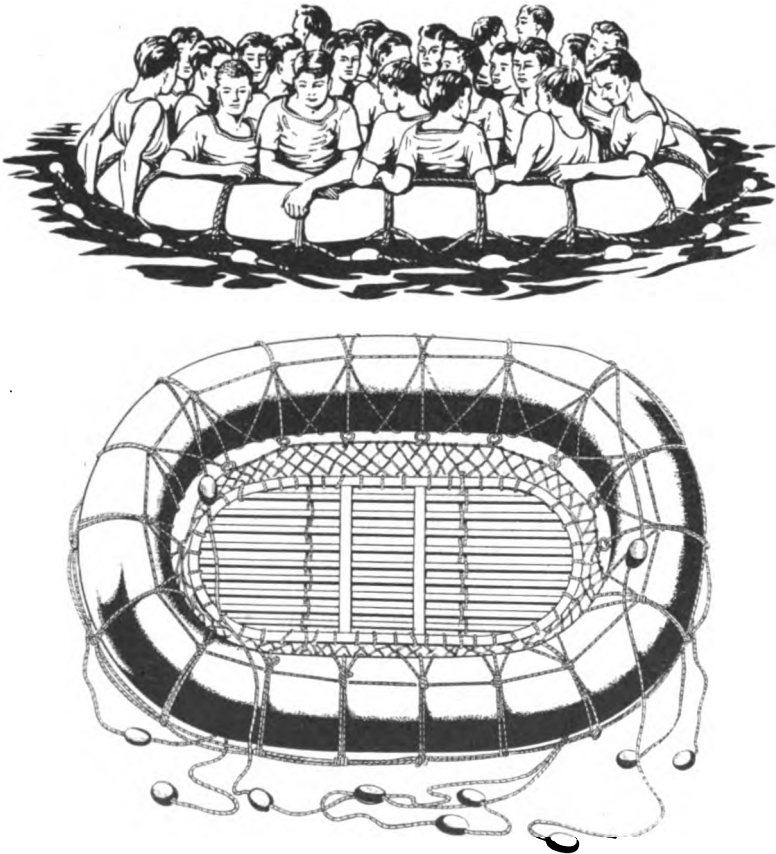


Fig. 229. Carley life-float

These floats are supplied in the Royal Navy in two sizes, and each is designated either by its pattern number or by the number of persons it is rated to support both inside and outside the tube ; a 20-man float, for example, will support 12 men inside on the platform, and eight men outside clinging to the beackets of the life-line.

The floats may be stowed in a nested stowage flat on deck, on platforms such as the tops of turrets, on sloping skids, or upright against a screen near the ship's side ; they may also be slung upright from the sides of the superstructure or from the shrouds of a mast, whence they can be slipped to fall clear of the ship's side into the water. When slung from the superstructure

the sling comprises three legs spliced on a ring ; the two lower legs are shackled to eye-bolts in the superstructure, and the upper leg is held by a rigging slip shackled to an eye-bolt in the superstructure.

These floats should not be repainted because the weight of successive coats of paint will reduce their buoyancy. Their stowages, slings, equipment and launching arrangements should be inspected at regular and frequent intervals, and each float should be tested for water-tightness at intervals of not more than six months.

A water-gauge and a stirrup-type hand-worked air-pump are provided for carrying out the air-test. Air is pumped into each compartment in turn and each must maintain a water-gauge pressure of 4 inches. The test should be carried out in the manner described below :—

Select any compartment for the initial test, remove its plug, connect up with it the air-pump and water-gauge, and pump air into it until the water-gauge registers a pressure of 4 inches. If no drop in pressure is recorded remove the plugs of the adjacent compartments, and if there is then no drop in pressure the compartment under test can be considered water-tight. Then carry out the same procedure with the next compartment, but in this case it will only be necessary when testing the bulkheads for air-tightness to remove the plug of the next untested compartment, because the bulkhead between the compartment under test and the compartment already tested can be considered intact. Continue this procedure until all compartments in turn have been tested.

If a compartment fails to maintain the air pressure mark a plain cross alongside its plug if it is the main tube which is leaking, but if a bulkhead is leaking mark an arrow alongside the cross to point in the direction of the defective bulkhead. A total of ten bulkhead leaks can be accepted provided that not more than three are in consecutive bulkheads, and a total of six main-tube leaks can be accepted provided that not more than three are in consecutive compartments. If a greater extent of leakage is detected the float must be condemned and returned to dockyard for repair.

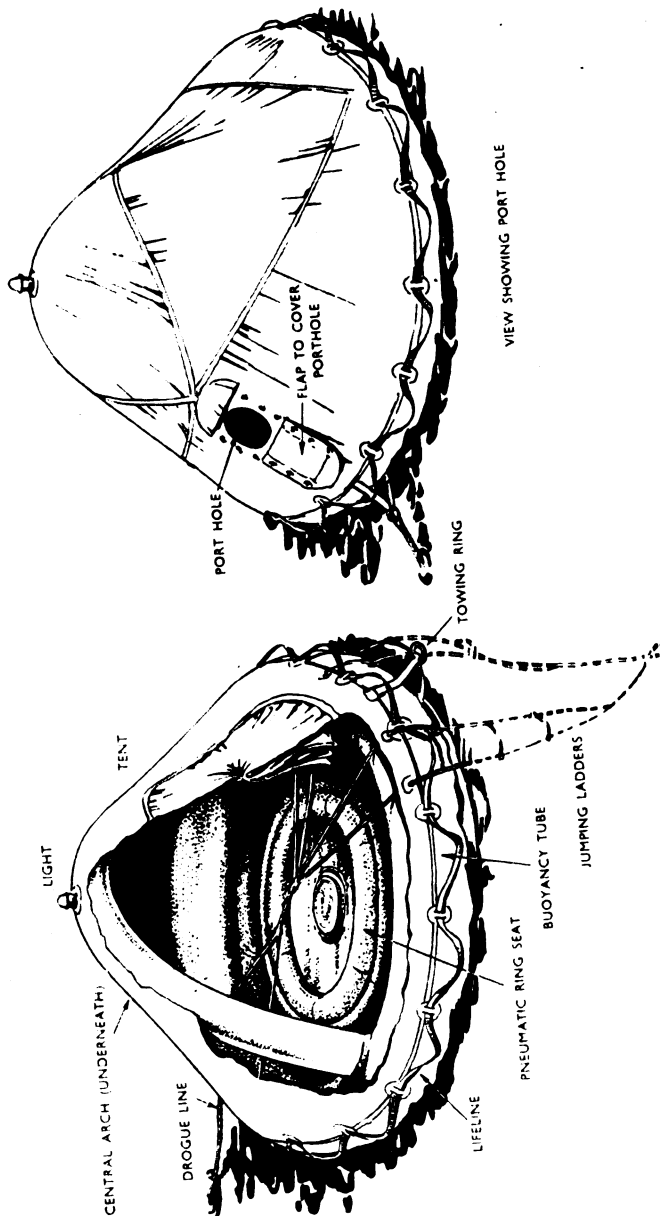
Details of the two sizes of Carley life-floats are given in the table on page 352.

SMALL LIFE-FLOAT

This is at present (1950) provided in the Royal Navy for small vessels instead of Carley life-floats, but it may be superseded by the " eight-man inflatable life-raft " described on page 363. It is a solid box-shaped float made of expanded rubber and covered with ply-wood. Each float is fitted with a painter and a life-line becketed round the outside. Details of this type of float are given in the table on page 352.

INFLATABLE LIFE-RAFTS (Fig. 230(i) and (ii))

These are now (1950) undergoing trials and will probably be introduced in the Royal Navy as the standard life-rafts for H.M. ships. They are designed to support men clear of the water and to protect them from the elements, and they have the added advantages over Carley floats of being lighter and requiring a smaller stowage space. They are provided in two sizes, the larger having a rated capacity of 20 men, and the smaller of 8 men. Each raft carries its own inflating device, consisting of a steel bottle filled with CO_2 gas under pressure which is released by a lanyard operating an opening mechanism in the head of the bottle. When deflated, each raft is packed in a water-proof and fire-resistant valise which is so constructed that the raft is forced out of the



8 MAN INFLATABLE LIFE-RAFT
Fig. 230 (1)

valise by being inflated ; the valise, with the raft in it, can therefore be cast overboard, and the raft can then be inflated from on deck by means of its lanyard. The larger raft when packed in its valise can be transported by four men, and the smaller raft by two men.

The rafts are made of three-ply, yellow, rubberised cotton fabric, and consist principally of a buoyancy tube fitted with a floor, and a tent supported by one or two arched tubes attached to, and connected with, the buoyancy tube. The arched construction, in addition to providing a means for erecting and supporting the tent, facilitates the righting of the raft should it capsize. The two rafts described below and illustrated in Fig. 230 are prototypes which are now (1950) undergoing tests, and they may differ from those which are eventually provided as standard equipment.

The eight-man inflatable life-raft (Fig. 230(i)) has a circular buoyancy tube of an overall diameter of 9 feet, on the top of which is fitted a single arched tube to which is attached the tent ; inflating the raft automatically erects the tent. A life-line is becketed round the outside of the buoyancy tube, and a rope net for boarding the raft is fitted to the tube below the tent opening ; on the side of the tube opposite the boarding position is fitted a drogue and line, which is streamed as the raft inflates, so that when the raft is inflated it will ride with the tent opening and boarding position on its lee side.

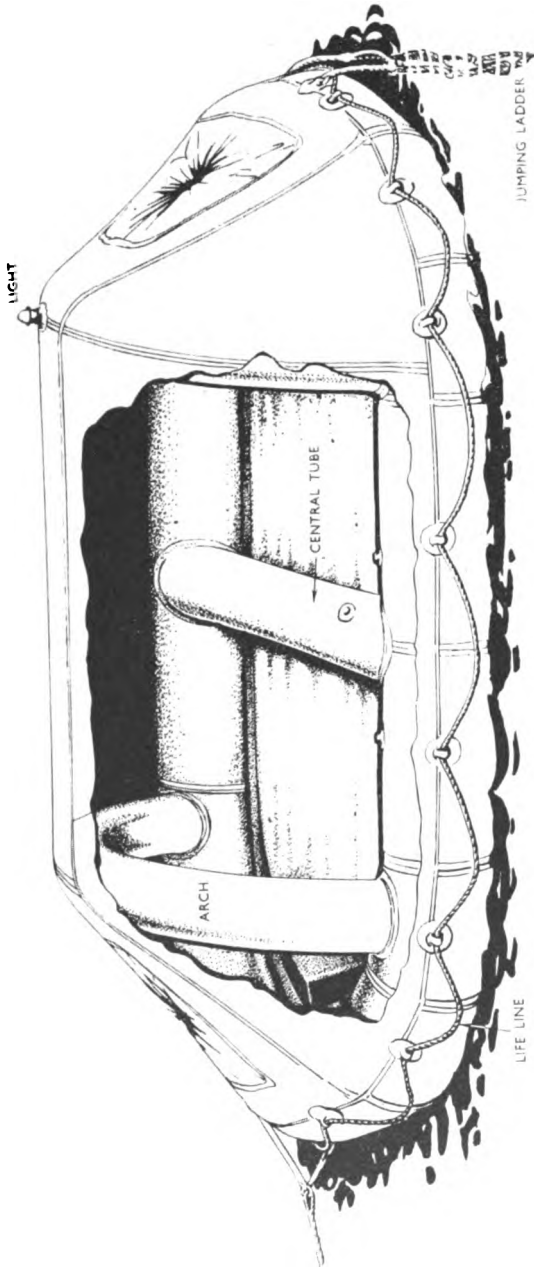
The circular tent opening is shaped like a short sleeve and is closed by draw strings from inside the tent in rather the same way as a sponge-bag. A port-hole, which can be closed by a flap, is fitted in the side of the tent opposite to its opening to enable the occupants to attend the drogue and its line. On the top of the tent is fitted a battery-operated electric light for indicating the position of the raft at night.

The upper side of the floor of the raft is fitted with a circular inflatable cushion of the tubular type which provides a seat for the occupants and also insulates them from the coldness of the sea, and on the under side of the floor are fitted four collapsible water-pockets which act as stabilizers to prevent the raft capsizing in a lop. When it is desired to paddle the raft these water pockets can be tripped by a line so that they lie flat against the floor.

The buoyancy tube is divided into a number of water-tight compartments by fabric bulkheads fitted with special non-return air valves, so that a puncture in one compartment will not deflate the whole tube. CO_2 gas will expand to a greater degree in hot climates than in cold climates, and this is allowed for by regulating the pressure of the gas in the bottles when they are filled or topped up. The buoyancy tube is provided with hand-operated air-release valves which enable the raft to be deflated, and also enable any excessive pressure in the tubes caused by the heat of the sun to be reduced ; the buoyancy tube is also fitted with inflation valves so that the pressure in the tube can be topped up when necessary by means of hand-operated bellows provided with the equipment of the raft.

The raft may be provided with the following equipment : leak stoppers for repairing small holes such as bullet holes ; hand-bellows for topping up the air in the raft tubes ; a rescue quoit and line for hauling men in the water towards the raft ; buoyant torches, a buoyant knife, paddles, distress signals, a fishing kit, a heliograph, water, food, and medical kit.

The 20-man inflatable life-raft (Fig. 230(ii)) is of similar construction to the eight-man raft with the following differences. The buoyancy tube is of oval



20 MAN INFLATABLE LIFE-RAFT

TENT CUT AWAY TO SHOW INTERIOR

Fig. 230 (ii)

shape, 16 feet long and 10 feet wide, and is fitted with two arched tubes to which is attached the tent ; when fully inflated the overall height of the raft is 4 ft. 7 in. The buoyancy tube is strengthened amidships by a tube running athwartships from side to side, and it is also strengthened against hogging by two truss-ropes running from end to end at floor level, one each side of the centre-line. The tent, which is stretched between and secured to the arched tubes, is fitted with a sleeve-opening at each end.

Maintenance.—Both the eight-man and twenty-man rafts should last for five years without a major refit, but they require regular and careful maintenance. Neither the raft nor its valise should ever be painted, and it should be stowed in a place free from damp or undue heat. The raft should be unpacked at regular intervals, preferably on a dry day, and its equipment and fittings, particularly the mechanism of the inflation and deflation valves and of the CO₂ bottle, should be carefully inspected, and the CO₂ bottle be carefully weighed to ensure that it contains the correct quantity of gas for the climate in which the ship is at the time. The raft should then be dusted liberally with French chalk to preserve the rubberised fabric, before it is repacked in its valise and returned to its stowage. At intervals of about 12 months the raft should be tested by casting it overboard in its valise and then operating its inflation mechanism. The raft should then be loaded with weights equivalent to its man-carrying capacity and left to float for long enough to ensure that it is in all respects fit for further service.

FLOTANETS

These are provided in many of H.M. ships, and consist of nets made of cordage rove through rings of cork which will support a number of men in the water. They are provided in two sizes, 7 ft. by 11 ft. to support 9 men, and 9 ft. by 20 ft. to support 22 men. They are stowed rolled up in convenient positions round the ship's superstructure, and should be unrolled before being cast overboard.

Life-boats

The remarks in this section refer only to life-boats for British merchant ships.

NUMBER CARRIED

The number of life-boats carried by a British merchant ship depends upon the trade in which she is engaged. Any sea-going cargo ship must carry on *each* side of the ship a sufficient number of boats to accommodate *all* her crew ; in other words she must carry twice the minimum number of boats required to accommodate all her crew. A foreign-going passenger ship, except one engaged in the cross-channel trade or on other similar short voyages, is only required to carry a sufficient number of life-boats to accommodate all the passengers and crew for which she is certified.* Passenger ships engaged in the home trade or in the cross-channel trade or on other similar short voyages, also excursion steamers, are required to carry sufficient life-boats to accommodate only a

*A cargo ship has to carry twice as many life-boats as a passenger ship, in proportion to the number of persons on board, for the following reasons : a cargo ship when badly damaged may take on so heavy a list that the boats on one side of the ship only can be lowered ; but a passenger ship is equipped with special pumping and flooding arrangements by which a heavy list can be reduced to within 15 degrees of the upright, thus enabling the boats on both sides of the ship to be lowered.

percentage of their certified total number of crew and passengers, the numbers varying from 40 to 70 per cent. according to the route on which the vessels ply or the trade in which they are engaged ; but they must carry in addition sufficient buoyant apparatus to support the remainder of their passengers and crew.

CLASSIFICATION

Life-boats are classified as follows :—

Class I.—Open boats with rigid sides, propelled by oars or a hand-operated mechanism, and/or sails, and fitted with either :

- (a) internal buoyancy tanks, or
- (b) internal buoyancy tanks, and external means of buoyancy such as slabs of cork fixed to the hull of the boat.

Class III.—Boats similar in construction and means of propulsion to boats of Class I, but not fitted with either internal or external means of buoyancy.

Class A.—Motor boats, similar in construction and means of buoyancy to boats of Class I, but fitted with a compression-ignition engine capable of propelling the boat at a speed of at least six knots in smooth water when fully laden, and capable of propelling the boat astern.

Class B.—Motor boats, similar in all respects to motor boats of Class A, but the engines need not be of the compression-ignition type, and a speed of at least four knots in smooth water when fully laden will suffice.

All vessels except harbour craft, pleasure boats, small fishing boats and vessels plying in inland waterways and smooth-water estuaries, must carry Class I life-boats.

All foreign-going ships and passenger ships engaged in home trade (except excursion steamers) must carry one or more motor boats in accordance with the following scale :—

	<i>Number of life-boats carried</i>	<i>Number and class of motor boats to be carried</i>
Foreign-going, and home trade passenger ships	13 or less 13 to 19 20 or more	1 of Class B 1 of Class A 20 of Class A
Foreign-going freighters	—	1 of Class B

EMERGENCY BOATS

All passenger-carrying ships, whether foreign-going or home-trade, must carry two boats on davits, one each side, ready for immediate use when the ship is at sea. These boats may be part of the ship's complement of life-boats, but they should not normally be more than 26 feet in length.

SPECIFICATION AND RATING

All life-boats must be constructed to comply with the specifications laid down by the Ministry of Transport for each class of boat. Class I boats for foreign-going ships should be not less than 24 feet in length, and no boat should

be less than 16 feet in length. All boats should be amply stable in a seaway, have sufficient freeboard when fully laden, be strong enough to be lowered with their full complement of persons and equipment on board, and they must not weigh more than 20 tons when fully loaded.

The number of persons which any boat is rated to carry is estimated by calculating the cubic capacity of the boat in cubic feet and dividing the result by 10 for boats of Classes I(a) and III, and by 9 for boats of Class I(b).

The cubic capacity of a boat is calculated from the formula

$$l \times b \times d \times 0.6,$$

where

l = the inside length in feet from stem to stern post or transom ;

b = the greatest outside breadth in feet ;

d = the inside depth in feet amidships, from keel to top of gunwale or bottom of rowlocks ;

if she is a motor boat, however, the volume of her power unit and accessories, and the volume of her wireless apparatus and searchlight (if carried), must be deducted from the cubic capacity obtained by this formula.

RADIO EQUIPMENT AND SEARCHLIGHTS

All foreign-going ships and home-trade passenger ships must carry some type of radio equipment for use in their life-boats.

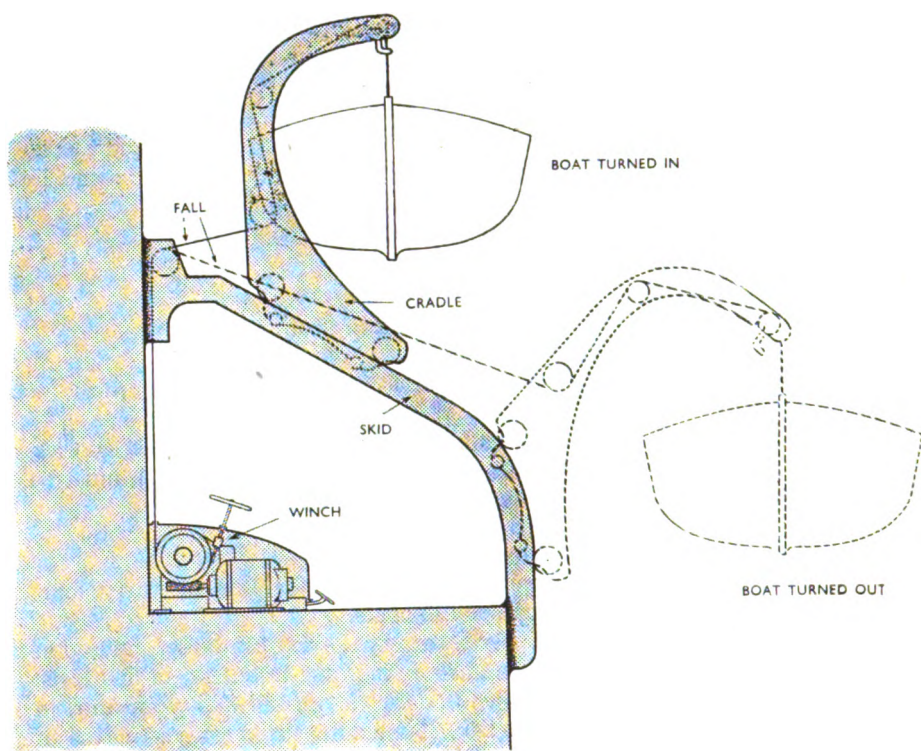
Each Class A motor boat must carry a battery operated radio set, housed in a cabin, and capable of transmitting and receiving on a frequency of 500 Kc/s. The set must be capable of being operated by an unskilled person, and, in addition to the normal transmission key, it must be fitted with a means of transmitting automatically the international distress and alarm signals. The battery must have sufficient capacity to work the receiver for four hours and subsequently to work the transmitter for two hours under full power. The boat's engine must be fitted with a dynamo for re-charging the battery, and when the ship is at sea the batteries must be topped up to full charge weekly by the ship's radio officer.

Foreign-going passenger ships with less than 20 boats (except ships on short passages) and all foreign-going freighters must carry a battery-operated, buoyant, portable radio set capable of transmitting and receiving on a frequency of 500 Kc/s. The set must be water-tight and sufficiently robust to be dropped from a height of 20 feet into the sea without suffering damage. It must be capable of being operated by an unskilled person, and, in addition to the normal transmission key, it must be fitted with a means of transmitting automatically the international distress and alarm signals. The battery must have sufficient capacity for the distress and alarm signals to be transmitted ten times in succession, and thereafter once an hour over a period of 48 hours, as well as being able to maintain reception over the same period. The set should be kept in the ship's chart room, ready to be placed immediately in any of the ship's boats ; at weekly intervals it should be tested and its battery charged.

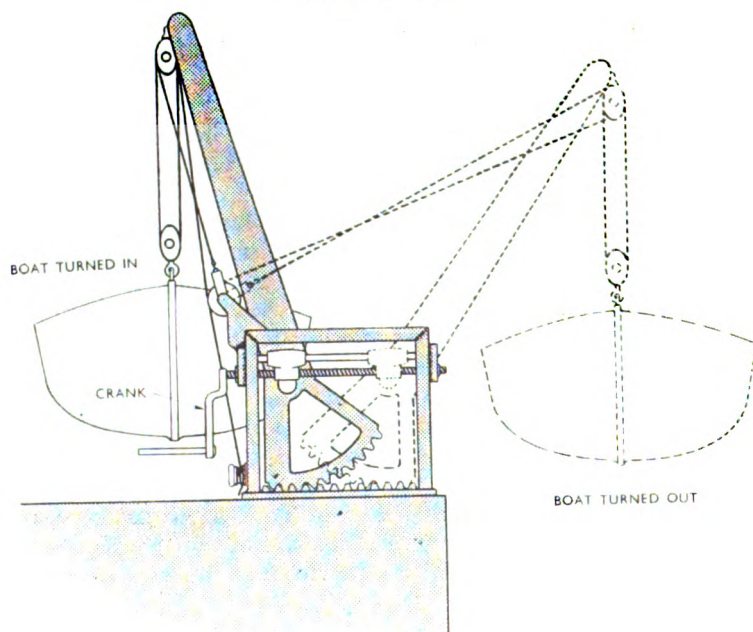
Each Class A motor boat should also carry a searchlight fitted with an 80-watt lamp, capable of effectively illuminating a lightly coloured object, 60 feet wide and 200 yards distant, for a period of six hours.

STOWAGE AND HANDLING

A pair of davits must be provided for each life-boat carried by a freighter. The number of pairs of davits required to be carried by a passenger ship depends



(i) GRAVITY TYPE



(ii) LUFFING TYPE

Fig. 231. Merchant ship's davits.

chiefly on her length and the individual capacities of her life-boats, and to a certain extent on the trade in which she is engaged. Where the number of life-boats required to be carried exceeds the required number of pairs of davits, the life-boats may be stowed one above the other so that one pair of davits may serve two or more boats. Where boats are stowed one above the other the stowage of the lower boat must not interfere with the launching of the upper boat, and if the lower boat requires lifting before being swung out, the falls must be power-operated. Each pair of davits must be situated clear of other pairs, and the handling arrangements of one pair must not impede or interfere with those of another pair. The davits and stowage arrangements must permit of the boats being launched when the ship is listing up to 15 degrees to either side. Many life-boats have a pair of skids clamped to their inboard sides to enable them to slide down a listed ship's side as they are lowered, without suffering undue damage ; when the boat is waterborne the skids are unclamped and jettisoned.

All ships over 150 feet in length, except those plying in smooth or partially smooth waters, must be fitted with either the " luffing " or the " gravity " type of davit for boats weighing not more than four tons in their turning-out condition, and with the " gravity " type only for all boats weighing over four tons in a similar condition. The " luffing " type of davit is also known as the quadrantal davit, one type of which is illustrated in Fig. 231(ii), which is canted outboard by means of a crank handle. The " gravity " type davits, illustrated in Fig. 231(i), are " S "-shaped, and each is made in two parts, the fixed part being called the " skid " and the movable part the " cradle ". The cradle, which supports the boat, is mounted on rollers and can move up or down the skid and both cradle and boat are slung on a single-part fall rove round sheaves and led to a power-operated winch. When the brake of the winch is released the cradle with the boat moves by gravity down the skid which is so shaped that at the lower end of its travel the cradle cants outboard and so places the boat into a position ready for lowering.

The boat's falls of all foreign-going ships (except those of low freeboard at light-load draught), and the falls of all boats weighing over four tons when fully loaded, must be of wire rope and be worked by power-operated winches. The falls of the emergency boats carried by passenger ships may, however, be of manila rope. Where one pair of davits serves two or more boats, each boat must be provided with separate falls. Two life-lines must be fitted to the davit spans of life-boats, and four life-lines must be fitted to the davit spans of emergency boats. Each boat position must be provided with emergency lighting, and with a ladder reaching from the embarkation position to the water. All life-lines, falls and ladders must be long enough to reach the water with the ship at light-load draught and listed 15 degrees to either side.

The lower blocks of the falls must not be fitted with a hook, and the boat's slings must be so fitted that they can be disengaged quickly, but not necessarily simultaneously, from the falls.

EQUIPMENT

Each life-boat must be fitted with a life-line becketed round the outside of the boat, and the hull must be fitted with bilge rails cut with hand grips to which are secured lines passed round the boat for righting her when capsized. In addition, each boat must be equipped with the following gear :—

a full single-banked set of oars and two spare, also a steering oar suitably marked to distinguish it from the others (Class A boats need carry only half a set of oars and crutches) ;

a set and a half of crutches, secured in the boat by lanyards ;

a mast or masts with wire rope stays, and orange-coloured sails carrying identification markings, complete with all rigging and gear (Class A boats need not carry masts and sails) ;

a rudder secured to the boat by a lanyard, and a tiller ;

a compass in a binnacle with means of illumination ;

two plugs for each plug hole, secured to the boat by lanyards ;

two painters—one shackled to the stem, and the other secured in the bows for slipping by a strop and toggle ;

a boat-hook, and two buoyant heaving lines ;

a sea anchor, and one gallon of vegetable, fish, or animal oil in a container, which can be attached to the sea anchor and is suitable for distributing the oil on the water ;

a hand-bailer and two galvanised iron buckets, each secured to the boat by lanyards ;

a hand-bilge-pump ;

an oil lantern, trimmed and filled with sufficient oil to burn for 12 hours, and two boxes of matches in a water-tight container ;

an electric torch suitable for morse signalling, with two spare batteries and bulbs ;

a daylight signalling mirror, two buoyant smoke signals giving off orange-coloured smoke, two parachute signals capable of giving a bright red light at high altitudes, and six hand-flares giving a bright red light ;

a first-aid outfit in a water-tight case ;

two hatchets (one forward and one aft) and a combined jack-knife and tin opener, each secured to the boat by a lanyard ;

a weather-tight locker for stowage of small items of equipment ;

an inventory of the equipment carried.

RATIONS

Each life-boat of a foreign-going ship, except ships plying on short passages, must be provided with the rations specified in the following scale for each person the boat is rated to carry :—

three quarts of fresh water, or more if practicable ;

16 oz. of biscuits ;

16 oz. of barley sugar ;

16 oz. (by weight) of sweetened condensed milk of first quality (the standard tin contains 16 ozs. of milk).

The food must be packed in water-tight containers, each labelled with its contents, and stowed in water-tight lockers. The water must be kept in special containers (usually sealed tins or barricoes), and at least one dipper with lanyard attached must be provided together with at least three rust-proof mugs one of which must be graduated in $\frac{1}{2}$, 1 and 2 oz. measures (20 oz. by liquid measure are equivalent to one pint, which is considered to be a sufficient daily ration to sustain life in tropical climates). If the water is kept in barricoes it should be changed weekly, and the barricoes should occasionally be flushed with a solution of bicarbonate of soda to keep them sweet.

CERTIFICATED LIFEBOATMEN

A certificated lifeboatman is a seaman who holds a certificate issued by the Ministry of Transport to the effect that he has passed an examination in the launching and handling of ship's life-boats. The crews of all foreign-going and home-trade passenger ships must include such men, the number depending upon the number of life-boats carried and the rated complement of each boat. The following table shows the minimum number of lifeboatmen who must be included in the complement of each boat carried :—

<i>Rated complement of boat</i>	<i>Minimum number of certificated lifeboatmen</i>
Less than 41 persons	2
From 41 to 61 persons	3
From 62 to 85 persons	4
More than 85 persons	5

Miscellaneous Life-Saving Equipment**SCRAMBLE NETS**

These are used in the Royal Navy to enable men floating in the water alongside a rescuing ship to climb up her side. They are made of cordage or wire rope rigged on spars, and are stowed rolled up in convenient positions round the ship's sides. When unfurled they should hang about a foot clear of the ship's side and should reach from the gunwale to well below the waterline when the ship is at light-load draught. The bottom of the net should be weighted to ensure that it hangs below the waterline.

LINE-THROWING APPLIANCES

A line-throwing appliance (usually of the gun or rocket type) must be carried by all merchant ships except those plying in smooth waters or inland waterways. The appliances must be capable of throwing a line a minimum distance of 250 yards in calm weather, and the equipment must include four such lines, each at least 290 yards in length and with a minimum breaking stress of 250 lbs., together with four cartridges or rockets.

H.M. ships carry a line-gun, somewhat like a rifle, which throws a small projectile with a length of nylon line attached to it. This gun has a range of about 250 yards in calm weather.

RED DISTRESS SIGNAL FLARES

The flare provided in the Royal Navy is cylindrical in shape and rather larger than a hand torch. It is held in the hand, is lit by a tear-off strip situated in the head of the flare and burns for about 35 seconds ; four such flares are provided for each boat or raft carried by a ship. The flare provided in British merchant ships burns for about 35 seconds and, at the same time, projects five stars, one at a time and at intervals of about six seconds, to a height of between 100 and 200 feet.

ROCKET LIFE-SAVING APPARATUS

Life-saving Stations

Numerous life-saving stations are established round the coasts of Great Britain and Northern Ireland for rescuing shipwrecked mariners or assisting vessels in distress by means of life-boats or the rocket life-saving apparatus. Those which are rocket life-saving stations are administered by the Ministry of Transport (H.M. Coastguard), and their situations, together with details of the assistance they can afford, are given in the relevant volume of the *Admiralty Sailing Directions*.

As this apparatus is used for rescuing the crew of a ship stranded close inshore, it is usually provided at those stations which are situated in the vicinity of cliffs or high land, and in other places where a life-boat cannot get close inshore.

Description and Method of Operation

The apparatus comprises a rocket and line, a tail-block rove with an endless whip, a jackstay and traveller, and a breeches buoy. The rocket, which is secured to a one-inch line of tarred hemp 250 fathoms in length, has a range in still air of 450 yards; it is fired from the shore and aimed to pass over the ship.* When the rocket-line has been secured in the ship a tail-block, through which is rove an endless whip of $1\frac{1}{2}$ -inch manila, is hitched to its shoreward end.

The crew of the ship haul in the rocket-line, tail-block and whip, and then secure the tail-block to the mast or superstructure as high up as is conveniently practicable, bearing in mind that the jackstay, when passed, must be secured at a point two or three feet above the tail-block.

The jackstay is of 3 inch manila, 120 fathoms in length, and has a becket spliced into it a few feet from the end. One part of the endless whip is

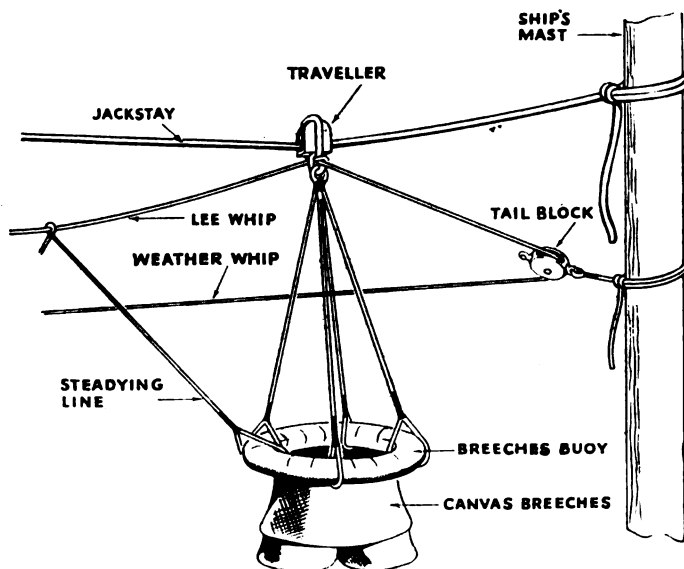


Fig. 232. Rocket life-saving apparatus—rig of jackstay and breeches buoy

*If a particularly heavy gale is blowing directly onshore initial connection may be made by the ship firing a line to the shore; the rescuers then hitch a stouter line to the ship's line, and, when the crew has hauled it on board, the tail-block and whip are hitched to the stouter line.

hitched to the jackstay by reeving its bight through the becket and making a clove hitch on the bight round the jackstay. When the tail-block is secured on board, the rescuers haul the end of the jackstay out to the ship by means of the endless whip.

When the end of the jackstay is hauled on board it is brought up between the two parts of the endless whip and secured to a point two or three feet above the tail-block. The whip is then unhitched from the jackstay, care being taken to ensure that the whip is clear of the jackstay and free to run through its block.*

The rescuers then set the jackstay up taut, fit the inverted single block, which forms the traveller, on the jackstay, and bend the bight of the endless whip to the becket of the traveller. The out-haul part of the endless whip is called the "weather whip" and the other part the "lee whip".

The breeches buoy, which is a Kisbie buoy fitted with a four-legged sling and a divided canvas trunk in the form of a pair of breeches, is slung on the traveller, and a steadying line is rigged from the shore side of the buoy to the lee whip. The traveller with the breeches buoy is then hauled out to the ship by the weather whip.

The first member of the crew to be rescued then steps into the breeches of the buoy, facing shoreward, and steadies himself by grasping the steadying line; the rescuers then haul the buoy ashore by the lee whip. This operation is continued until all the crew are rescued.

SIGNALS FOR OPERATING

Each stage of the operation should be indicated by a signal.

In the ship, by day, the signal may be given by detailing a man to stand clear of the remainder of the crew and wave his arm, or his cap, or a white flag; by night it may be given by waving a white light or flare.

On shore the signal is given by day by waving a red flag, and by night by waving a red light.

If the signals are made by waving with a vertical motion (up and down) their general sense is *Affirmative*, e.g. "Haul away", "Line made fast"; but if they are made by waving horizontally (from side to side) their general sense is *Negative*, e.g. "Avast hauling", "Slack away".

In poor visibility the signals may be made in the ship by giving a short blast on the siren, foghorn or whistle, and they may be made on shore by firing a sound rocket or blowing a whistle.

The various stages which should be indicated by signal are as follows:—

- In the ship* : when the rocket-line is in hand ;
 when the tail-block is secured ;
 when the jackstay is secured ;
 when a man is ready to be hauled ashore in the breeches buoy.
- On shore* : when the tail-block is hitched to the rocket-line and ready to be hauled on board.

In addition to these signals communication by flashing or hand flags should be established between ship and shore whenever possible; in most rescue crews there is a trained signalman.

*Sometimes a lighter jackstay of 2-in. manila, may be used instead of the 3-in. manila jackstay. In this case the end of the jackstay is hitched to the tail of the tail-block and passed to the ship with the block and endless whip.

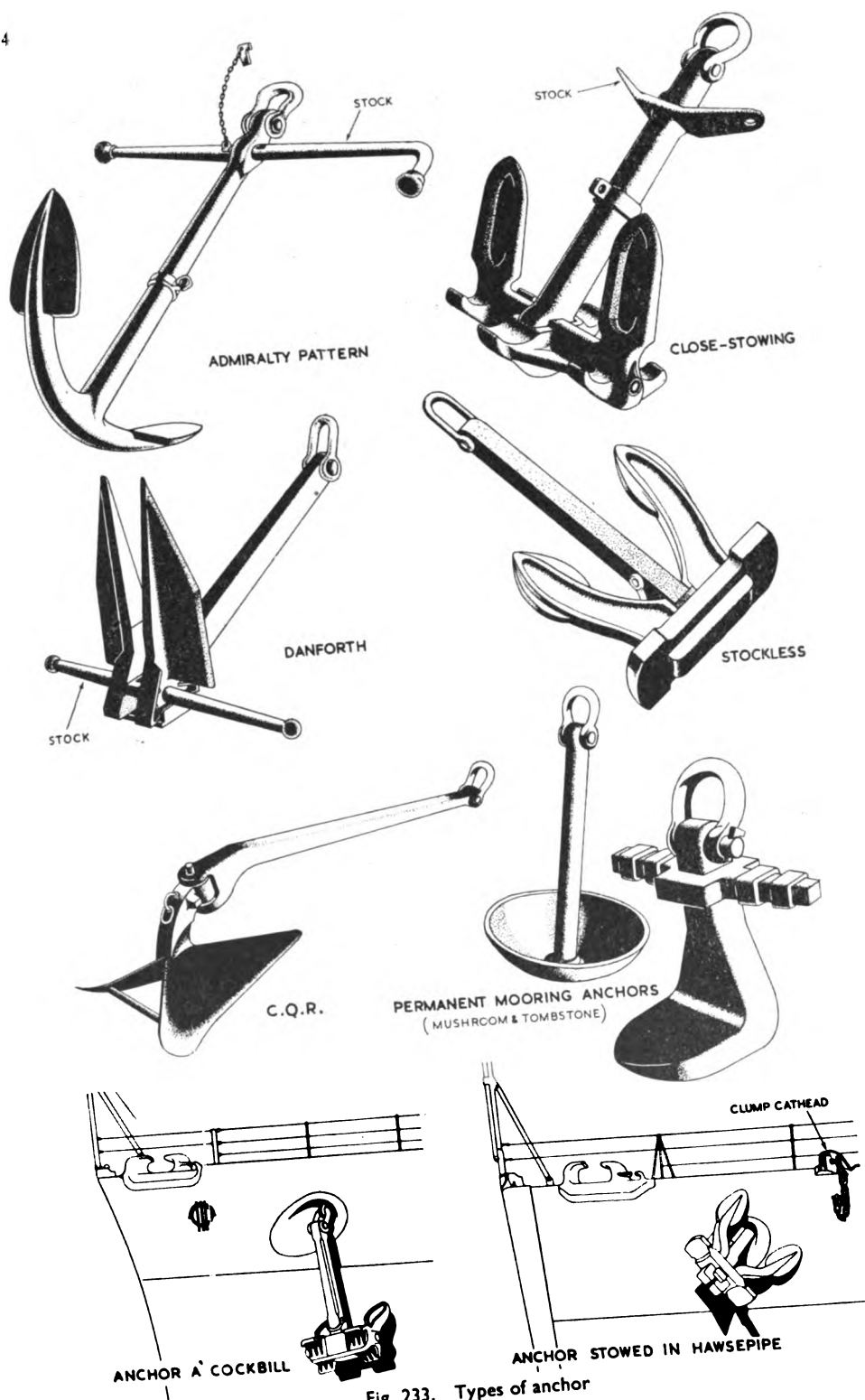


Fig. 233. Types of anchor

CHAPTER IX

Anchors and Cables, and Anchor Work

ANCHORS AND CABLES

Types of Anchor

THE bigger the ship the heavier must be her anchors. Details of the anchors carried by H.M. ships are given in the table on page 398. Anchors also vary in design, and the most common types are shown in Fig. 233.

ADMIRALTY PATTERN ANCHOR

In spite of its name the Admiralty Pattern anchor is much older than the Admiralty itself, and for long was considered by seamen to afford the greatest holding power for a given weight ; now, however, some patent designs are superior in this respect. It is still used for ships' kedge anchors and for boats' anchors, but is now being replaced by more modern designs.

When the anchor is let go the stock comes to rest horizontally on the bottom, and as the flukes are set at right angles to the stock they stand up vertically ; then, as the anchor takes the weight of the ship, the lower fluke digs into the bottom and holds. Its disadvantage is that because the upper fluke sticks up from the bottom the anchor may well be dislodged through being fouled by the bight of its cable as the ship swings to wind and tidal stream ; it is also dangerous if let go in shallow water, because a vessel may impale herself on the upper fluke when the tide falls. Owing to its stock the anchor cannot be stowed in a hawsepipe and so must either be stowed on deck or slung in some position from which it can be let go, and a large anchor of this type is awkward to stow.

STOCKLESS ANCHOR

As its name implies, this anchor has no stock and can therefore be hove right home into the hawse pipe ; it is thus easily secured and can quickly be made ready for letting go again. This type of anchor has good holding power and is used for the bower and sheet anchors of H.M. ships, and also for the stream anchor if a stern hawsepipe is fitted. The arms are not made in one piece with the shank, as in the Admiralty pattern anchor, but pivot about a pin which passes through the crown. As the anchor is dragged along the bottom by the cable the tripping palm tilts both flukes downward so that they dig into the bottom. The angle through which the flukes can tilt is limited by stops forged in the crown.

Several types of stockless anchor may be met with, both in H.M. ships and in merchant ships. The most common are the Admiralty Standard, the Byer's, and the Taylor's ; their general design is similar and they vary only in detail.

DANFORTH ANCHOR

This is an anchor of a new design, with a better holding power for a given weight than the older types, and is now (1949) being introduced in the Royal Navy. It resembles a lightly built stockless anchor, both in appearance and method of operating, but has a small stock which passes through its crown and

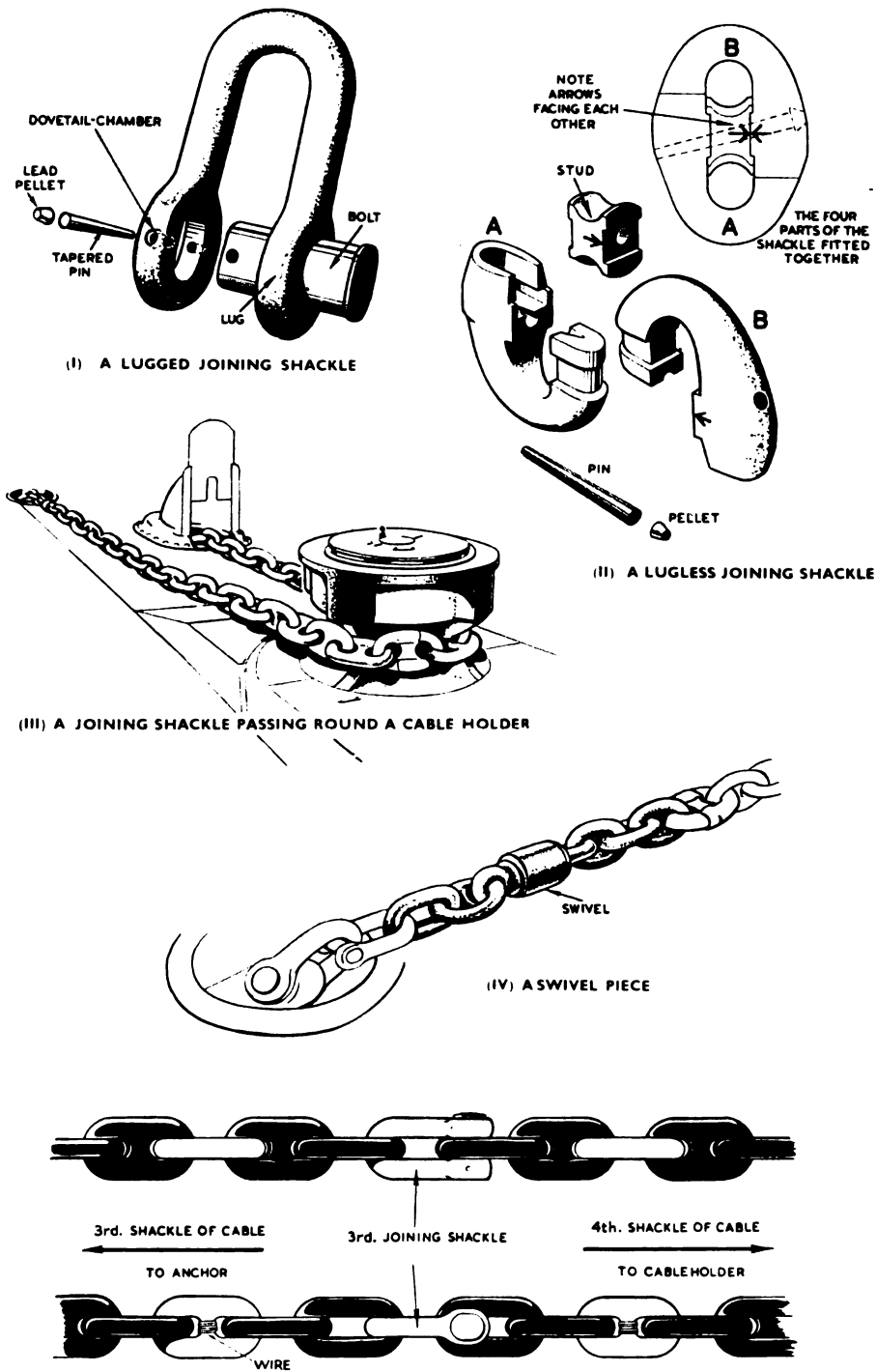


Fig. 234. Component parts of chain cable

prevents the anchor from rolling when its flukes dig into the bottom. It fits comfortably into the hawsepipe and can be secured as efficiently as a stockless anchor. Its disadvantage is that it may not hold when at short stay.

C.Q.R. ANCHOR

This anchor is also of new design and has the same holding power for its weight as any other existing type. It has a bent shank with a plough-shaped fitting hinged to the end, and buries itself deeply when pulled by its cable. It is used in the Royal Navy for small vessels such as motor boats and M.T.B.s, but has not been used for larger ships as it will not stow in a hawsepipe.

CLOSE STOWING ANCHOR

This anchor works on the same principle as the stockless anchor, which it resembles except that a small stock is fitted near the ring. It is an old fashioned type but is still sometimes used in the Royal Navy as a kedge or stream anchor.

Chain Cable

An anchor cable can vary in size, material and length, from the 20 fathoms of 2-inch manila of a small boat to the 500 fathoms of 3-inch chain of a battleship. The bower cables of most seagoing vessels are made of studded chain, because chain is better able than fibre or wire rope to withstand the wear and tear imposed on a ship's cable; the studs in the links strengthen them and prevent the cable from kinking.

Nowadays (1951) studded chain anchor cable is made in lengths of 15 and $7\frac{1}{2}$ fathoms, and these lengths are called respectively "shackles of cable" and "half-shackles of cable". Before 1949 a shackle of cable supplied to the Royal Navy was $12\frac{1}{2}$ fathoms long, and many examples of this cable will still be met.

A ship's bower cable is usually made up of four half-shackles of cable and a number (depending upon the size of the ship) of shackles of cable. The half-shackles are usually inserted in pairs, one pair at the outboard end next to the anchor, and the other midway between the outboard and inboard ends. This method of making up a bower cable in shackles and half-shackles enables the cable to be parted at numerous points throughout its length, and, for example, thus facilitates the insertion of the mooring swivel at the point required when mooring ship.

JOINING SHACKLES (Fig. 234)

The shackles which join the shackles of cable to each other may be either "lugged" or "lugless"; the latter is the more modern type, but many examples of the provision of lugged shackles may still (1951) be met with.

The lugged joining shackle is a large straight shackle whose bolt is secured by a tapered steel pin and lead pellet. This pin fits into a tapered hole drilled through the bolt and one lug of the shackle, and when the pin is right home a small conical recess, called the "dovetail chamber", is left clear above its head. The lead pellet is hammered broad end first into this chamber so as to fill it completely and thus keep the pin in place. Before inserting the pellet the remains of the last one must be scraped out of the chamber, otherwise the new pellet may work out; this is done with a small tool called a "reamer".

Except for the anchor shackle all lugged shackles should be fitted into the cable with their lugs facing aft, so that the lugs will not foul any projections on the deck as the cable runs out. The anchor shackle, being already in the hawse

pipe, is in no danger of fouling anything on its way out, but as it may foul the stem or some projection on the ship's side while the anchor is being hove in it should be fitted with its lugs facing outboard.

The lugless joining shackle is of nickel steel and made in three parts, one of which is the stud. The two main parts are attached to the ends of the cable and then fitted together, and the stud then slides in place and locks the whole. The stud is secured by hammering a tapered pin and pellet into the hole drilled diagonally through all three parts of the shackle.

When parting a lugless joining shackle it is better to use a "top swage" than to hit it directly with a hammer. The top swage is a kind of large punch which is shaped to fit the shackle, and its use avoids damage to the accurately machined surfaces of the shackle.

Joining shackles being larger than the links will jam or be strained if they are made to pass round the sprocket of a cable holder, or the gypsy of a windlass, while on the wrong slew. Both types of shackle should lie vertically (as shown in Fig. 234(iii)) as they pass round a cable holder; when passing round the gypsy of a windlass, however, both types of shackle should lie horizontally because the axis of the windlass is horizontal. To ensure that all joining shackles pass round a cable holder or gypsy on the same slew a shackle of cable is always made up of an odd number of links.

SWIVEL PIECES (Fig. 234(iv))

The swivel pieces which are fitted at each end of the complete cable each consist of a swivel with a few links each side of it, and they differ in detail with the type of joining shackle used. The illustration shows the arrangement of the outboard swivel with both lugged and lugless shackles. The inboard swivel for both types is secured to the cable clench with a lugged joining shackle. The cup swivels designed for lugged shackles should always be inserted in the cable with their cup facing aft; the box swivels may be inserted either way round.

MARKING OF CABLE (Fig. 234(v))

The component shackles and joining-shackles of an anchor cable are numbered consecutively from its outer to its inner end, the first joining-shackle being that which joins the first and second shackles together. To indicate a joining-shackle and its number it is painted white and, except for the first joining-shackle, the stud of a link on each side of it is marked by turns of wire; the second link on each side of the second joining-shackle is so marked, as is the third link on each side of the third joining-shackle, and so on up to the innermost joining-shackle.

TYPES OF CABLE

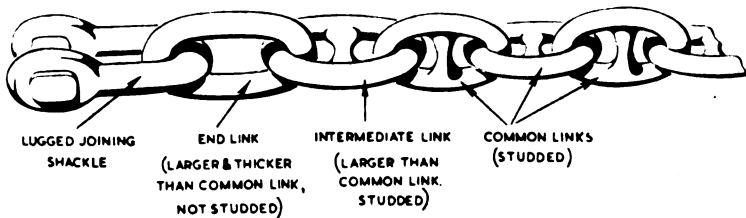
There are many different types of ship's cable. Those used in the Royal Navy are: Admiralty quality forged steel, Admiralty quality mild steel, Admiralty quality wrought iron, Merchant quality forged steel, Merchant quality mild steel, and Merchant quality wrought iron. Forged steel cable is used for all modern ships because it is 40 per cent. stronger than wrought iron cable and so permits of a much handier cable of considerably less weight. Forged steel cable is easily identified by the studs of alternate links being of different size and by every stud being forged in one piece with the link, whereas the studs of wrought iron cable are separate and welded in place. Admiralty

quality wrought iron cable is still (1951) used in older ships but is being superseded by forged steel cable ; its strength is the same as that of Merchant quality cable but it is of superior finish. Mild steel cable is not supplied to British built warships, but it may be found in Canadian or American built ships. In the Royal Navy merchant quality cable is used only for Fleet auxiliaries and similar craft.

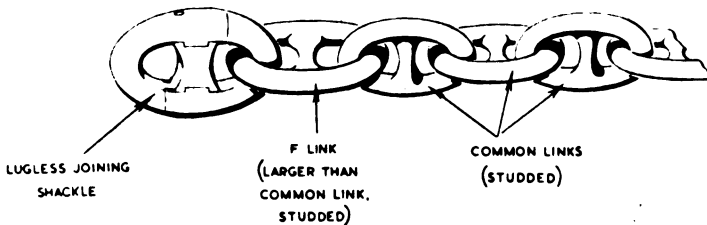
Particulars of the cables supplied to H.M. ships are given in the table on page 399. The size of cable quoted in this table and always used in practice is the diameter of the element of metal forming the common link ; (for definition of a common link, see below). The size always quoted for an anchor shackle, joining shackle, or other cable gear, is that of the cable with which it is intended to be used.

COMPONENTS OF A SHACKLE OF CHAIN CABLE

The links forming the greater part of each length of cable are of uniform size and are called "common links", but those at each end of each length are stepped up in size to take the joining shackles.



(i) CABLE WITH LUGGED JOINING SHACKLE



(ii) WROUGHT IRON CABLE WITH LUGLESS JOINING SHACKLE



(iii) FORGED STEEL CABLE WITH LUGLESS JOINING SHACKLE

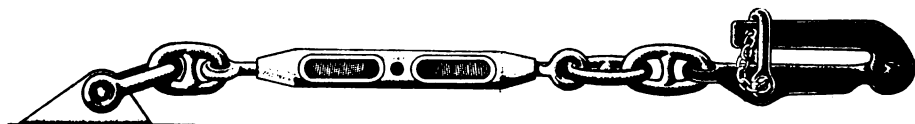
Fig. 235. Component parts of a shackle of chain cable

The components of the three types of cable supplied to the Royal Navy are described below.

Cable with lugged joining shackles (Fig. 235(i)).—As the lugs of a joining shackle are too big to pass through a common link an unstudded link has to



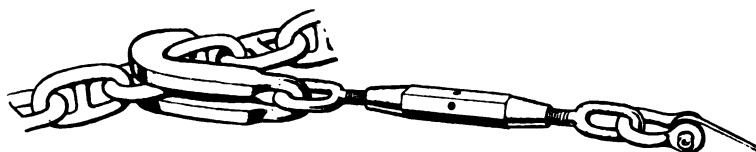
A BLAKE SLIP



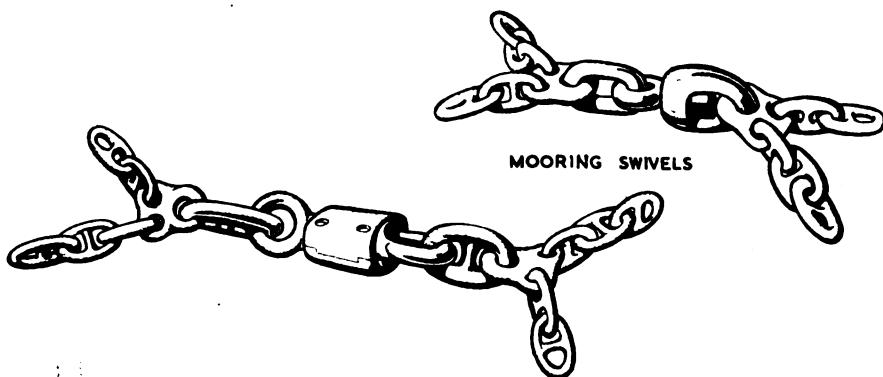
A SCREW SLIP



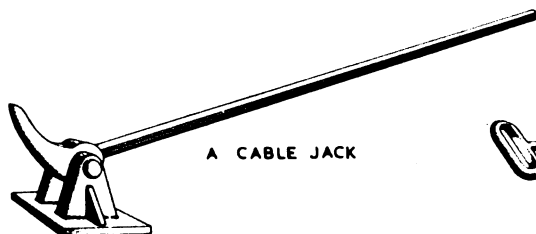
A SENHOUSE SLIP



DEVIL'S CLAW



MOORING SWIVELS



A CABLE JACK



A CHAIN HOOK

Fig. 236. Cable gear and fittings, I

be provided to take them. This is called the "end link", and being unstudded it has to be made thicker than the common link as it must be of the same strength. A slightly enlarged studded link, called an "intermediate link", is inserted to connect the end link to the first common link. The illustration shows the position of these links at one end of a length of this cable. The lugged anchor shackles for this cable are, of course, also designed for shackling on to an end link.

Wrought iron cable with lugless joining shackles (Fig. 235(ii)).—As the lugless joining shackle is just too large to fit on the common link a slightly enlarged studded link is fitted at each end of each length of cable. This enlarged link is called an "F link" and is slightly smaller than the intermediate link. The illustration shows one end of a length of wrought iron cable fitted with lugless joining shackles. Lugless anchor shackles for this cable are designed to fit an unstudded end link.

Forged steel cable with lugless joining shackles (Fig. 235(iii)).—The common links of forged steel cable fit round one another more loosely than do those of wrought iron cable and can take a lugless joining shackle; F links are therefore not required and so each length consists of common links only.

Cable Lockers

The cable lockers provide the stowage for the cables and lie beneath the navel pipes, usually on the lowest deck. Their sides are usually of steel plating, perforated to ventilate and drain the cable. The bottom plate has an additional large hole through which the inboard end of the cable is passed and shackled to its cable clench, which is secured to the structure of the bottom of the ship. The clench is tested to 20 per cent. above the proof load of the cable. The cable locker is, as far as possible, shaped so that as the cable descends it will automatically stow itself clear for running out. Though the design of these self-stowing lockers is based on many years of experience it is far from infallible, and hands must always be stationed in the cable locker flat to assist the correct stowage of the cable by means of chain hooks and strands.

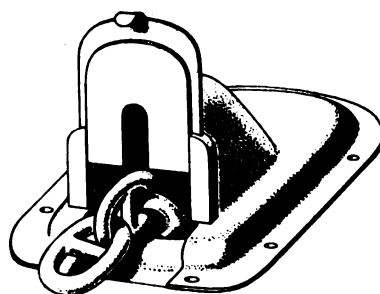
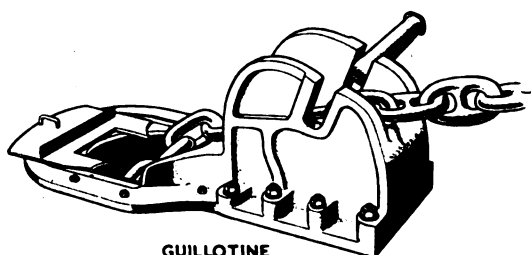
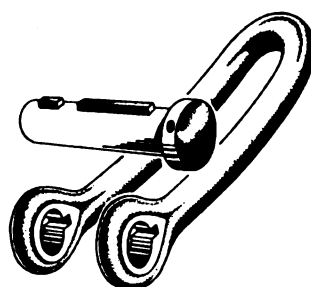
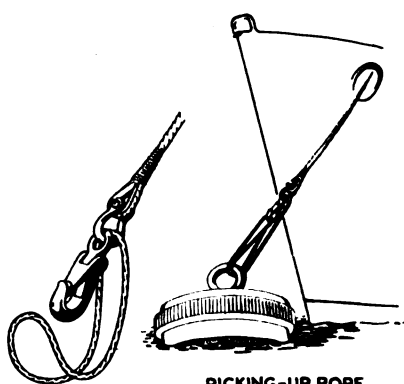
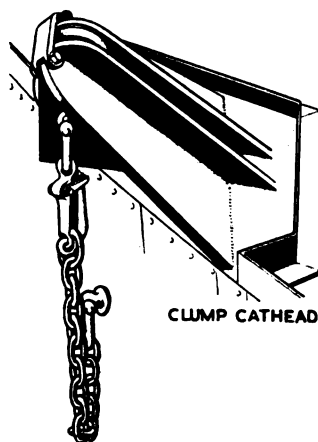
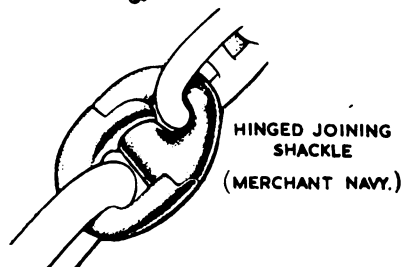
When a cable locker is not self stowing an eyeplate is fitted to the deck-head above each corner of the locker; strands are attached to these eyeplates and are hitched and then unhitched successively to the cable as it comes in so as to guide it into each corner of the locker. The cable of a small ship is easily stowed by hand as it descends from the navel pipe.

Cable Gear and Fittings

Stoppers.—Cable stoppers usually known as "slips", are provided to hold the cable when the ship is riding by it, or to hold the cable temporarily so that the inboard part of it can be handled, to bring it to the capstan, for example.

The Blake Slip consists of a length of chain, one end of which is shackled to a deck clench and the other fitted with a slip, as illustrated in Fig. 236. The slip fits across a link of the cable and the tongue of the slip is secured in place by a link and a pin.

The Screw Slip differs from the Blake slip only in that a bottle-screw is incorporated in the chain between the slip and the clench. The bottle-screw enables the anchor to be hove hard home in its hawsepipe, thus securing it for sea.

**COMPRESSOR****BONNET****GUILLOTINE****JOGGLE SHACKLE****PICKING-UP ROPE****CLUMP CATHEAD****BUOY SECURING SHACKLE****HINGED JOINING SHACKLE
(MERCHANT NAVY.)****Fig. 237. Cable gear and fittings. II**

The Senhouse Slip is designed to hold the end of a length of cable. The tongue of its slip is passed through a studless link and not across it. It was formerly used to secure the inboard end of a bower cable to its cable clench, but nowadays (1951) it is only found in the catting sling of an anchor.

The Blake slip and screw slip are each tested to half the proof load of the cable, and their clenches (or "lug plates") are tested to 20 per cent. more than the slips.

In many merchant ships the cable is stoppered by a "Devil's claw", as illustrated in Fig. 236.

A Riding Slip is a Blake slip shackled to a clench on the deck immediately above each cable locker, and it is put on the riding cable when the ship is at anchor; it is tested to half the proof load of the cable. The ship rides on the brake of the cable holder, and the riding slip acts as a preventer should the brake render.

The Compressor is fitted in small ships instead of a riding slip. It is incorporated in a fixed bonnet over the navel pipe and consists of a spade-shaped wedge of steel on a screwed spindle, operated by a hand-wheel; when the wheel is turned the wedge is moved across the mouth of the navel pipe until it nips a link of the cable against the lip of the navel pipe and so holds it fast (see Fig. 237).

In many merchant ships a "guillotine", as illustrated in Fig. 237, takes the place of the riding slip or the compressor.

The Bonnets for covering the navel pipes are portable, except when a compressor is incorporated in them. They are provided with sliding shutters which fit over a link of the cable, and when the cable is secured for sea the bonnets are caulked with oakum to make them water-tight (see Fig. 237).

The Clump Cathead.—When a large ship is moored to a buoy the bridles of her cable are passed through one of the hawsepipes, and to leave enough room for them in the hawsepipe the anchor must first be removed and stowed. Clump catheads, which consist of a sheave mounted on two brackets on each bow of the ship just abaft the hawsepipes, are provided for slinging the anchors; when thus slung an anchor is said to be "catted". To cat the anchor it is first hove up to this sheave by a wire pendant called a "catting pendant", and then secured there by means of a chain sling which is fitted with a long end link to take the tongue of its special Senhouse slip. Clump catheads are not fitted in destroyers and smaller vessels, because their bridles are led through the bull-ring on the stem head and so it is not necessary to cat the anchors.

A Catting Pendant is a wire pendant fitted at one end with a saddle link which distributes the weight of the anchor over the long bolt of the catting shackle. This shackle takes the ring of the anchor and therefore must be made very wide in the clear.

The Picking-up Rope is a wire rope by means of which the ship is hove up to a mooring buoy to enable her bridles to be shackled on to the ring of the buoy. It is fitted at one end with a spring hook and a long grommet strop, so that it can be quickly and easily secured to the ring.

The table below gives details of the picking-up ropes supplied to different classes of ships.

DETAILS OF PICKING-UP ROPES FOR SHIPS

TONNAGE, AND TYPE OF SHIP	SIZE AND TYPE OF WIRE ROPE	SIZE OF F.S.W.R. FOR STROP	HOOK PATT. NO.	SHACKLE PATT. NO.
2,000 and below ...	2½-inch F.S.W.R.	1½-inch	2097A	2024
2,000 to 3,000 ...	3-inch F.S.W.R.	2-inch	2097A	2024
3,000 to 5,000 ...	3½-inch F.S.W.R.	2½-inch	2096A	2023
5,000 and below 10,000	4-inch F.S.W.R.	2½-inch	2096A	2023
Cruisers of 10,000 tons and above	4-inch E.S.F.S.W.R.	4-inch	2098A	2025
Aircraft Carriers ...				
Battleships ...				

The Buoy-securing Shackle is supplied for joining the ship's bridle of cable to the ring or reducing link of a mooring buoy, and it is therefore especially wide in the clear. It can be used with either lugged or lugless shackles, and is tested to the proof load of its associated cable. The width in the clear for cable of all sizes is given in the following table :—

Size of Cable	Width of Shackle in the clear
1½-inch and below	3.25-inch
from above 1½ to 1¾-inch	4.5-inch
from above 1¾ to 1⅞-inch	5.75-inch
from above 1⅞ to 2-inch	7.25-inch
above 2-inch	8.25-inch

The Joggle Shackle is a long and slightly bent shackle, shaped to fit across a link of cable ; it is used for attaching a wire rope to a bight of cable. The bolt fits easily in the lugs and is held in place by feathers protruding from it ; to remove or insert the bolt it must first be turned until the feathers are in line with the feather-ways cut in the lugs of the shackle. The table below gives the pattern numbers and proof loads of the joggle shackles supplied for different sizes of cable.

Size of Cable	Patt. No. of Joggle Shackle	Diameter of Bolt	Proof Load
		in.	tons
1⅞-inch and below ...	1938	1⅞	15
1½ to 2-inch inclusive ...	1938A	1⅞	25
2½ to 2¾-inch inclusive	1939	2⅞	30
2½-inch and above ...	1940	2⅞	40

An Adapter Piece consists of an end link and an F link joined together. It is used to attach an anchor shackle, or lugged joining shackle, to a length of cable which terminates in an F link, or in a common link of a steel cable.

The Mooring Swivel is used to prevent turns forming in the cables when a ship is moored between two anchors. It consists of a swivel with a three-eyed plate at each end, one eye of each plate being attached to the swivel,

either directly or by means of a special enlarged link, and the remaining two being linked to short legs of cable. The composition of these legs depends on whether the cable has lugged or lugless shackles ; for lugless shackles one leg consists of two F links (or common links for steel cable) and the other of three ; for lugged shackles one leg consists of a single unstudded link and the other of two unstudded links. Two types are provided, namely ; the " cup swivel " for wrought iron cable, and the " box swivel " for forged steel cable.

An Anchor Buoy is used to mark the position of the anchor when it is on the bottom, and is always streamed before the anchor is let go. Its use is of particular importance in crowded anchorages to enable other vessels to keep clear of your anchors and cables. The anchor buoy used in the Royal Navy usually consists of a strengthened barricoe, fitted with slings to which the buoy-rope is bent. To avoid damage by chafing on the bottom the buoy-rope is attached to the anchor by a short length of chain, which is shackled to the crown of the anchor. The length of the buoy-rope must be adjusted so that the buoy will continue to " watch " at high water ; a buoy is said to watch when it floats, and is not watching when carried under the surface by the stream or the rise of the tide. Buoys should be painted red for the port anchor, green for the starboard, and red and green for the sheet anchor.

An Anchor Strop is used as an additional preventer for securing the anchor for sea ; it consists of a wire strop rove through the ring of the anchor and shackled to eyeplates on each side and inboard of the hawsepipe.

The Cable Jack is a handspike mounted on a pedestal which functions as a fulcrum. It is used as a lever to lift up heavy cable so that, for example, the tongue of a Blake slip can be passed under it.

A Parting Strop is used to separate parts of cable which are lying close together, so that, for example, the tongue of a slip may be passed between them. The strop is passed through a link of one cable, beyond the stud, and secured to a convenient eyeplate. By veering the cables slowly part of their weight is transferred to the strop and the cables can then be separated.

A Hook-rope is a wire or fibre rope with a hook fitted to its end, and is much used for manhandling cable.

The Chain Hook is an iron hook with a long handle used for hauling detached lengths of chain cable when ranging it, for survey, for example. Chain hooks should never be used on the forecastle when working cable as they are liable to jam in the cable when it is moving ; a hemp strop is equally effective.

Capstans, Cable Holders and Windlasses

CAPSTANS (Figs. 238 and 239)

A capstan in its simpler form has a " barrel " or " rundle " mounted on a vertical spindle which is driven by a steam engine or electric motor, and is used for working hawsers or warps. In the event of failure of steam or electric power it may be rigged so that it can be worked by hand.

The barrel is waisted (*i.e.* made smaller in diameter at its middle than at its top and bottom) with the object of checking the tendency of the turns of rope to work up or down and form a riding turn as the capstan revolves. A riding turn is dangerous because it prevents the rope from being surged should the necessity arise ; immediately a riding turn develops the capstan must therefore

be stopped and then walked back until the riding turn is cleared. If the turns are reluctant to slip towards the middle of the barrel, slightly surging the rope will usually induce them to do so, and this can be helped by knocking them towards the middle with a heavy maul. Warping drums of winches and windlasses are similarly shaped for the same reason.

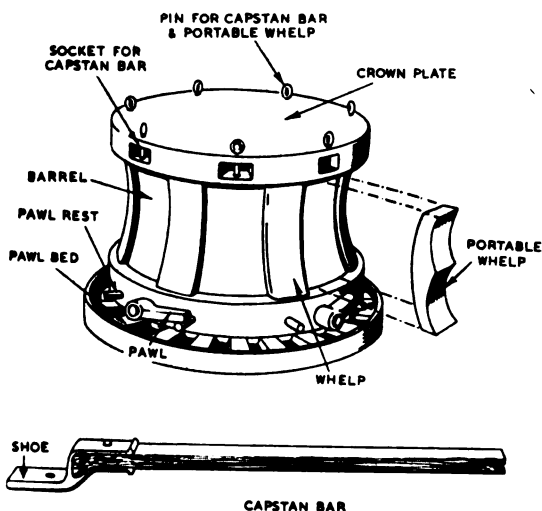


Fig. 238. A typical after capstan

Standing out at intervals from the barrel and extending from its top to its bottom are slight projections called "whelps", which are cast with the barrel and help it to grip the rope. The capstan illustrated in Fig. 238 is provided in addition with "portable whelps", which can be fitted round the barrel to make it "double waisted" and thus enable two ropes to be worked simultaneously by the capstan.

The barrel is keyed to its spindle, which is driven by the capstan engine through a worm and worm wheel; the worm drive ensures that no undue strain is transmitted by the capstan to the engine. To enable the capstan to be worked by hand its spindle can be disconnected from the worm gear by removing two bolts which connect the lower end of the spindle to the worm wheel, thus allowing the capstan and its spindle to revolve freely.

To work the capstan by hand, "capstan bars" are provided which fit into sockets round the head of the capstan. The bars, which are of ash, have a cast steel shoe on their inner ends and a horizontal slot cut in their outer ends, and they are secured in place by a rope called a "swifter". The swifter is a $1\frac{1}{2}$ -inch or 2-inch rope, having one end pointed, the other end fitted with a thimble eye, and a cut splice midway between the two ends; it is passed in the manner described below and illustrated in Fig. 239.

To pass the swifter, place the cut splice over the lower horn of the slot in one of the bars, and then work to the right and left of the cut splice. If working to the right grasp the swifter in the right hand abreast the next bar to the right, as shown in Fig. 239(i). Then turn the hand outward and downward, thus making a bight in the swifter, and place the upper part of the bight in the slot of the bar (Fig. 239(ii)). Now take the swifter round the lower horn of the slot, haul taut, pass it back through the slot, and then take it round the upper horn (Fig. 239(iii)). Now complete the figure-of-eight by passing the end of the bight through the slot, as shown in Fig. 239, and haul taut; then proceed in a similar manner with the next bar to the right.

When working to the left the procedure is similar except that the initial bight for each bar is formed with the left hand.

When all bars to the right and left of the cut splice have been swifted in, the swifter is secured to itself in the following manner: reeve the pointed end through the thimble eye of its other end, and haul taut; then bring the pointed end back through the slot of the last bar, over its upper horn and back through the thimble; then haul taut and secure with a hitch.

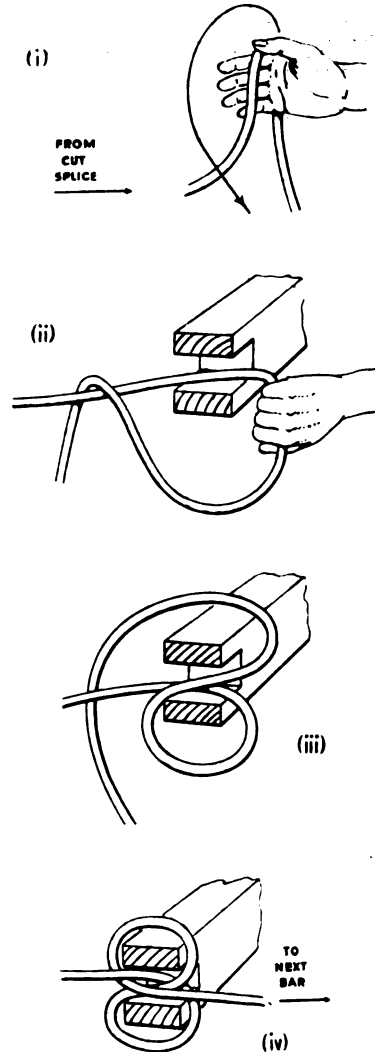


Fig. 239. Passing a swifter

The swifter must be passed as tautly as possible to keep the bars in place, and so they should be held up while they are swifted as this slightly reduces the spread of their ends; when the men man the capstan they will bear down slightly on the bars as they push against them and this will tend to tauten the swifter thus bringing an equal strain on all the bars.

When worked by hand any form of capstan must be provided with some means of preventing it from walking back (*i.e.* revolving in the reverse direction) should a sudden heavy strain be imposed on it by the hawser or cable which it is working. This is provided by a pawl and ratchet gear consisting of hinged pawls fitted at intervals round the skirt of the barrel; these can be lowered to right or left of their hinge pins on to a circular toothed rack, called the "pawl

bed", which is bolted to the deck below the skirt. Depending on which way the capstan is turned and which way the pawls are lowered they will either ride over, or engage with, the teeth of the pawl bed; when they engage with the teeth they prevent the capstan turning in the direction in which they are pointing. When the capstan is turned clockwise to heave in, the pawls must therefore be lowered to the right of their pins; and when it is turned anti-clockwise to heave in, they must be lowered to the left of their pins.

When the capstan is worked by its engine it is prevented from walking back by its worm gearing, and the pawls must then be disengaged from their bed because, if left engaged, reversing the engine would result in severe damage either to the engine or the pawls and pawl bed. To keep the pawls off their bed each pawl may be provided with a "pawl rest", and the bed may also be covered with a circular plate called the "pawl plate".

Fig. 240 shows a typical forecastle capstan for working the hawsers and cables of large warships. The barrel is formed by portable whelps, which, when removed, disclose the "sprocket" to which the cable can be brought. The projections on the sprocket are called "snugs", and are designed to fit and grip the links of the cable with which the ship is equipped so that the cable can be hove in or veered. In other respects this capstan is similar to that just described.

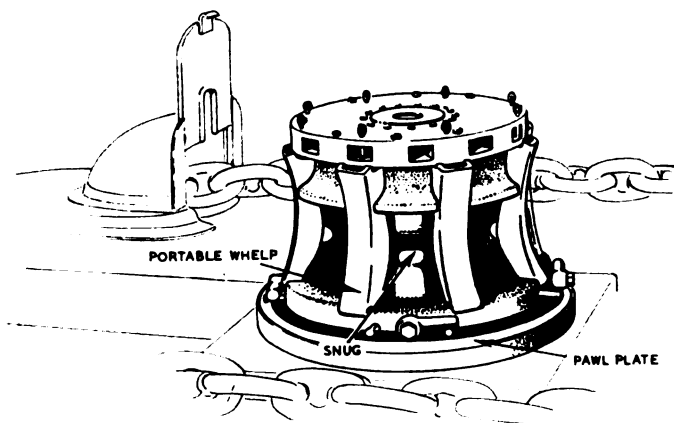


Fig. 240. A typical forecastle capstan

Because this capstan is usually situated before the navel pipes, "roller guides" which fit in sockets in the deck are provided to lead the cable aft from the capstan to the required navel pipe. Four sockets and three guides are provided, and by shipping two of the guides in the appropriate sockets the cable of either bower anchor, or of the sheet anchor, can be brought to the capstan and led to its appropriate navel pipe as shown in Fig. 241.

To bring a cable to the capstan a slip is first put on the cable, and then sufficient cable to pass round the capstan is hauled up from the cable locker and hung at the navel pipe by passing a bar through one of the links and laying it across the navel pipe. The bight of cable is then passed round the after side of the capstan, and led before and outside the rollers on the opposite side of the ship and thence to its navel pipe. When the cable is brought to the sprocket

care should be taken to ensure that it is correctly fitted to the snugs so that the joining shackles will pass round them on the correct slew.

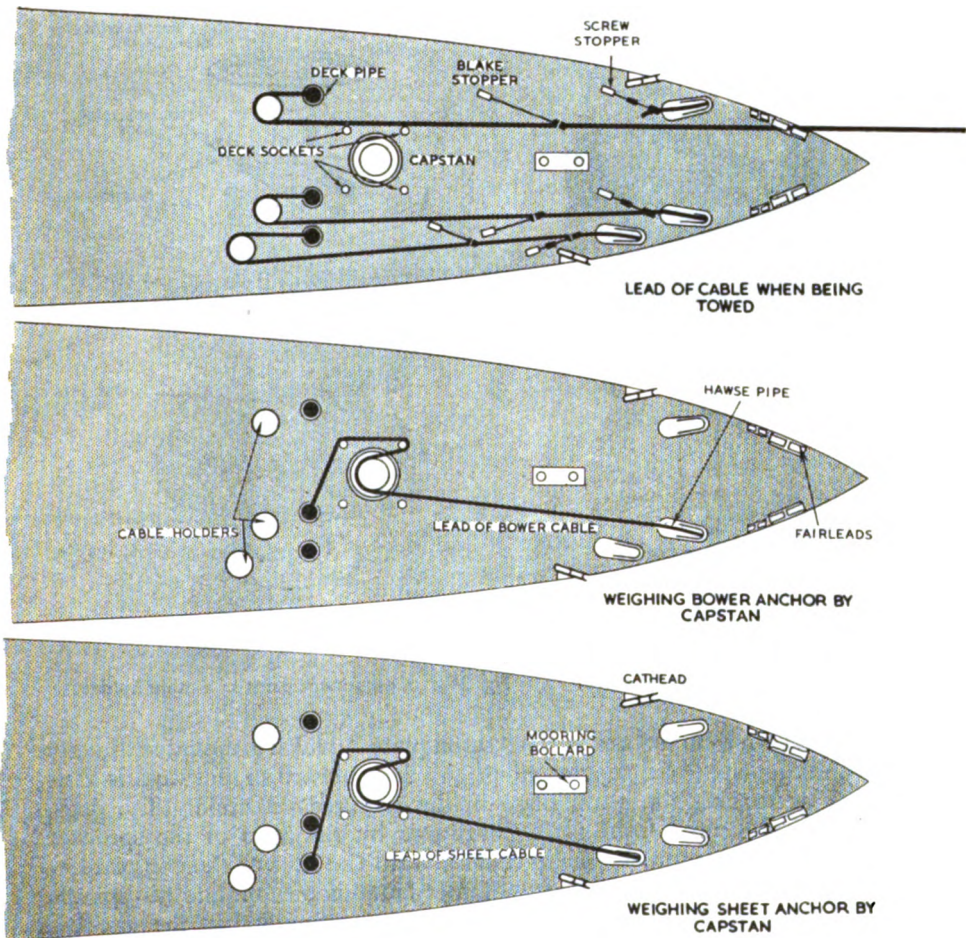


Fig. 241. Lead of cables for towing, and for weighing bower anchor by capstan

CABLE HOLDERS

A cable holder is designed solely for working cables. It consists of a sprocket which embodies snugs and is mounted on a spindle driven through worm gearing as illustrated in Fig. 242, either by the capstan engine or by its own separate engine.

The sprocket can revolve freely on its shaft, or be connected to its shaft by a dog clutch situated in the head of the sprocket. When it is disconnected the rotation of the sprocket can be controlled by a band brake operated by a handwheel; when connected the sprocket will hold the cable and can be made to heave in or veer the cable by driving the engine in the required direction.

The operation of the clutch is described below and illustrated in Fig. 243. A circular plate called a "dog plate" is keyed to the head of the spindle and revolves within the head of the sprocket. The dog plate is slotted to take two dogs which can be slid inwards or outwards along their slots. Each dog has a

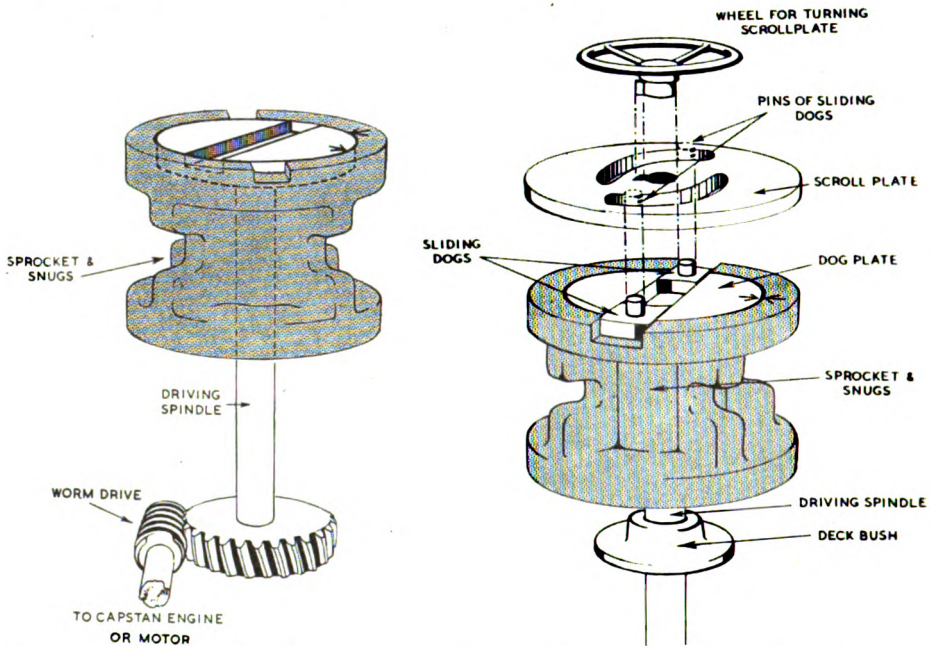


Fig. 242. A cable holder and its drive

Fig. 243. Component parts of a cable holder

pin which takes in a curved slot in the "scroll plate", which is mounted directly above the dog plate; the movement of the dogs inward or outward is thus controlled by turning the scroll plate in the required direction. The dogs, however, are prevented from sliding outwards by the head of the sprocket unless the slots in the sprocket head coincide with the slots of the dog plate.

To connect the sprocket to its spindle the brake is put on, and the spindle is slowly turned by the capstan engine until an indicating line on the sprocket head coincides with an indicating line on the scroll plate, in which position the slots in the sprocket head and dog plate will also be in line. The scroll plate is then turned by a hand lever until its pointer is opposite a pointer marked **IN GEAR**, in which position the dogs will have moved outwards and locked the dog plate and spindle to the sprocket. When the brake is taken off, the cable holder can then heave or veer cable.

To disconnect the sprocket from its spindle the brake is put on and the scroll plate turned until its pointer is opposite a pointer marked **OUT OF GEAR**, in which position the dogs will have moved inwards and unlocked the dog plate and spindle from the sprocket. Cable can then be allowed to run out freely by releasing the brake.

The operation of the brake is described below and illustrated in Fig. 244. The brake encircles the base of the sprocket, and consists of a band which is hinged at its middle and has each of its ends connected by links to the arms of a quadrant which can be turned about one of two pivots mounted on a brake

shoe. The movement of the quadrant, shoe, links and band is controlled by a hand-wheel connected to the quadrant by gearing. The movement of the wheel is recorded by a pointer which moves over a dial marked at three positions, namely, BRAKE TO BRAKE, BRAKE TO FREE, and BRAKE TO VEER.

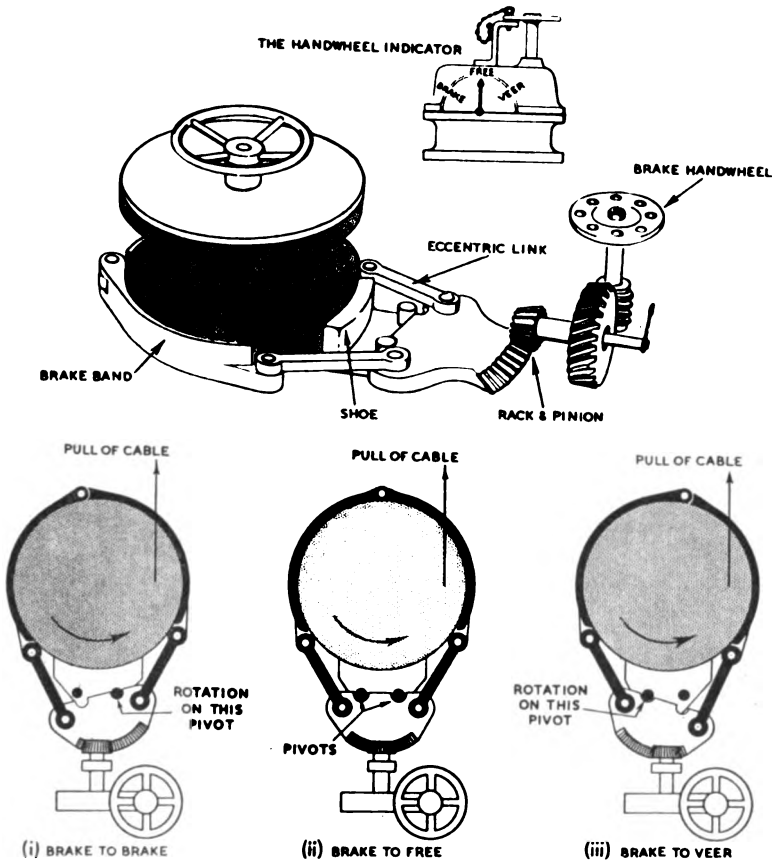


Fig. 244. Operation of the brake of a cable holder

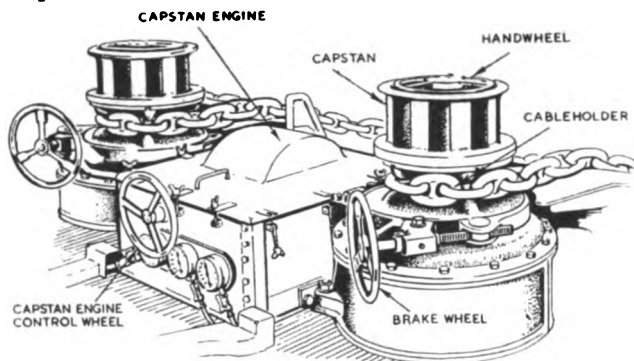
Brake to Free.—When the wheel and quadrant are in their central positions the band and the shoe are released from contact with the sprocket so that the sprocket can revolve freely on its spindle, and the pointer then indicates BRAKE TO FREE (see Fig. 244(ii)).

Brake to Brake.—When the wheel and quadrant are turned to the position at which the pointer indicates BRAKE TO BRAKE the quadrant rotates about one pivot of the brake shoe and forces the shoe and band against the sprocket in the same direction in which it is tending to revolve (see Fig. 244(i)). Any movement of the sprocket in this direction thus forces the shoe and band into closer contact with itself and thus applies the brake with greater force than is exerted by means of the handwheel.

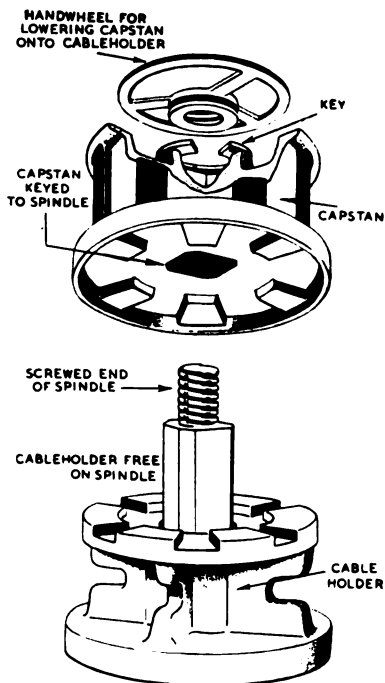
Brake to Veer.—When the wheel and quadrant are turned to the position in which the pointer indicates BRAKE TO VEER the quadrant rotates about the other pivot of the brake shoe and forces the shoe and band against the sprocket in the opposite direction to that in which it is tending to revolve (see Fig.

244(iii)). Any movement of the sprocket in that direction thus tends to remove the shoe and band from contact with it, and the brake is therefore held in contact by the force applied by the handwheel only.

The brake is used in the **BRAKE TO VEER** position for stopping or controlling the cable under all normal conditions of the cable running out. It is used in the **BRAKE TO BRAKE** position to hold the cable when the ship is riding to her anchor or made fast to a buoy, and to arrest or hold the cable in emergency; many are reluctant to use it in this position, however, because of an erroneous idea that it will then probably jam, but it will in fact only jam if then the engine is moved to veer the cable holder. The brake should never be applied when cable is being hove in or veered by the engine, and when the cable holder is connected up it should therefore be set to **BRAKE TO FREE**.



Combined capstans and cable holders of a destroyer



Component parts of a combined capstan and cable holder

Fig. 245.

COMBINED CAPSTAN AND CABLE HOLDER

Fig. 245 shows a type of combined capstan and cable holder, fitted in destroyers, in which the capstan is mounted above the cable holder and on the same spindle. The capstan is keyed to the spindle and can also slide up or down it, but the cable holder is not connected to the spindle in any way. The head of the spindle is cut with a screw thread which works in a nut fixed to the centre of a handwheel keyed to the crown of the capstan, so that when the handwheel is revolved the capstan is raised or lowered on its spindle. A number of dogs project at intervals round the bottom of the capstan barrel, and when the capstan is lowered on to the cable holder they engage in slots cut in the head of the cable holder sprocket, thus locking the cable holder to the capstan. When the capstan is raised by turning the handwheel the dogs are disengaged from their slots, thus freeing the cable holder.

To connect the cable holder to the capstan the capstan engine is turned until the mark on the bottom of the capstan barrel is in line with that on the head of the cable holder; the capstan is then lowered on to the cable holder by turning the handwheel on the crown of the capstan in the required direction, and the dogs then engage in their slots and lock the capstan and cable holder together.

To disconnect the cable holder from the capstan the latter is raised by turning its handwheel, thus disengaging the dogs from the sprocket and freeing the cable holder.

Each cable holder is fitted with a simple band brake, which bears on the skirt of the sprocket and is operated by a handwheel. The action of the brake is similar to that of a large cable holder when set to BRAKE TO VEER.

WINDLASSES

The chief difference between a windlass and a capstan or a cable holder is that the windlass is mounted on a horizontal shaft whereas the other two are mounted on vertical spindles. Although its primary function is to work the bower cables, the windlass is fitted with warping drums for working hawsers and thus combines in one machine the functions of both capstan and cable holders. All merchant ships are equipped with some form of windlass, but they are fitted in only the smaller warships because their height above the deck obstructs ahead gunfire at low angles of elevation.

The engine or motor of a windlass is usually situated directly abaft the windlass on the forecastle deck, and for the normal requirements of anchor work both engine and windlass can be operated by one man. The smaller windlasses can usually be worked by hand should steam or electric power fail. Fig. 246 shows a typical steam windlass which can also be worked by hand. Its shaft is driven by the engine through worm gearing, and a clutch is provided by which the gearing can be disconnected from the shaft when the windlass is to be worked by hand.

The two large gearwheels mounted centrally on the shaft and permanently keyed to it are provided for working the windlass by hand. The two sprockets for taking the two bower cables are mounted on the shaft outside the gear wheels, and are called "gypsies"; they are exactly similar to the sprocket of a cable holder, and care must be taken to bring the cables to them so that the joining shackles will pass round them on the correct slew.

Each gypsy can revolve freely on the shaft, or be connected to the shaft by its dog clutch. The clutch consists of a sliding collar keyed to the shaft and cut with dogs which fit into slots cut in the gypsy. To connect the gypsy

to the shaft the engine is turned until the slots in the gypsy are in line with the dogs, and the clutch lever is then moved so that the dogs engage in the gypsy, and the lever is locked in place. To disengage the gypsy the lever is moved in the reverse direction and slides the collar back along the shaft, thus disengaging the dogs from the gypsy.

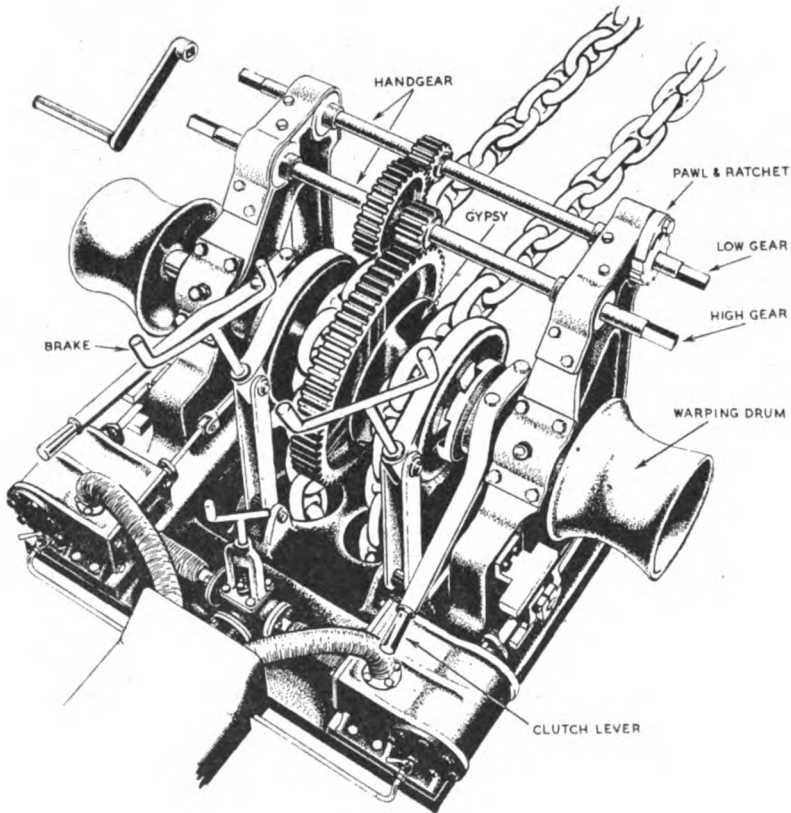


Fig. 246. A typical steam windlass

Each gypsy is provided with a simple band brake, operated by a lever, which can be locked in position. A warping drum is keyed permanently to each end of the shaft so that they always revolve with the shaft. The drums are not usually fitted with whelps.

The windlass can be worked by hand in either high or low gear, the low gear being used for breaking the anchor out of the ground and the high gear for heaving in cable.

To work the windlass by hand the engine is unclutched, the handles are shipped on the high or low gear shaft, as required, and the appropriate gypsy is clutched up. To prevent the windlass from walking back when cable is being hove in by hand a pawl and ratchet wheel are provided; they are situated on one side just below the hand shafts. The pawl must be engaged in its ratchet wheel whenever the windlass is worked by hand, and before the engine is unclutched or the brake taken off.

Steam and electric windlasses differ widely in size and detail; but all conform in principle to that described.

POWER OF CAPSTAN AND WINDLASS ENGINES OR MOTORS

The engines or motors of capstans, cable holders and windlasses, are designed to heave in both bower cables simultaneously at a speed of 25 feet of cable per minute under normal conditions, and to heave in slack cable at a speed of 40 feet of cable per minute. Their ability to meet these requirements is tested when ships undergo their acceptance or refit trials.

An electric capstan motor is usually fitted with a slipping clutch, in its driving mechanism, which is adjusted to slip when the maximum designed load of the motor is exceeded.

Instructions for periodical inspections of capstans, cable holders, windlasses and their associated machinery are given in the *Engineering Manual* and in *King's Regulations and Admiralty Instructions*. These cover also the inspection of the foot bearings and deck bushes of the shafts of capstans and cableholders, and the inspection of the clutch mechanisms of cableholders at six-monthly intervals by ships' staffs, and at yearly intervals by dockyard officers.

Maintenance, Survey and Testing of Anchors and Cables

The following are definitions of certain properties of chain cable and fittings referred to in this section :—

The Proof Load, in tons, of wrought iron cable up to $2\frac{1}{2}$ inches in size is $18d^2$ (approx.), and of larger wrought iron cable it is $(25 - 3d)d^2$, d being the size of the cable in inches.

The proof load of forged steel cable is 40 per cent. more than that of wrought iron cable of the same size.

The Breaking Stress of all cable is $1\frac{1}{2}$ times the proof load.

The Weight in Tons of one fathom of cable is $d^2 \div 40$

The Stowage Space, in cubic feet, required for 100 fathoms of cable is $35d^2$.

The Diameter of the Hawsepipe of a ship fitted with forged steel cable is $10d$, and that of the navel pipe is $8d$.

TEST AND MAINTENANCE

Before being accepted for service at sea all cable and its associated gear are subjected to a proof load test ; the proof loads of different cables are given in the specification *DNC/M/SWII*, but they can be found approximately from the formulae given above. In addition samples of cable and its associated gear are tested to destruction, in which the breaking load must be not less than one and a half times the proof load.

The strength of cables may eventually deteriorate from wear, corrosion, and fatigue ; fatigue is caused chiefly by the battering to which the cable is subjected when running out through the hawsepipe and navel pipe. Cables are therefore surveyed periodically, and are heat treated and retested at less frequent intervals.

The survey, details of which follow, should discover any deterioration caused by wear or corrosion, and should detect any flaw or crack in a link caused through fatigue, but it will give no guide to the brittleness of the cable. The survey also provides an opportunity for rectifying minor defects, cleaning and overhauling joining shackles, and transposing the more hardly worked lengths with others so that the whole cable will wear evenly. The periods at which survey, heat treatment for correction of brittleness, and testing, should

take place depend on the class of ship and her employment, and are given in B.R. 367, *Anchors, Chain Cables, etc.*

When a survey of cable is due the *King's Regulation and Admiralty Instructions* require the Commanding Officer of the ship to appoint two or three officers to carry it out, and to arrange for them to be assisted by a qualified blacksmith or shipwright. When the ship is in a dockyard port a smith from the dockyard is always employed and an item requesting his assistance must be put in the *Defect List*. Certain other gear such as wire hawsers and paravane towing chains must be surveyed at the same time, and a comprehensive report has to be forwarded in duplicate on *Form S.194* to the Senior Officer of the station.

PROCEDURE FOR SURVEY

To prepare for a survey the cable lockers must first be cleared and the cable ranged (*i.e.* laid out in fleets) on deck, or wherever convenient. If desired to range the cable along the bottom of a dry dock permission must first be obtained from the Superintendent of the Dockyard. Every shackle should be examined to ensure that the pin does not project, and then be broken (*i.e.* parted). All parts of the shackle should be carefully cleaned and then treated as follows:—

Pins must be rubbed over with stiff white lead, bolts and lugged shackles coated with warm tallow, and the machined surfaces of lugless shackles greased with Stauffer's lubricant, grade C. Every link of the cable must be tapped by a blacksmith to test it for a flaw, and carefully examined. Should the element of any link be found to have lost more than one tenth of its original diameter (or one eighth if the cable is smaller than $2\frac{3}{4}$ -inch), whether due to wear, corrosion or any other cause, the length of cable concerned should be condemned and renewed. Loose studs of iron cable must be caulked, for which a studding block is supplied, or renewed if necessary; instructions for tack-welding of loose studs (in iron cables of $2\frac{3}{8}$ -in. and above) is given in B.R. 367; the studs of forged steel cables are made in one piece with the links and therefore require no refitting. Swivels should be examined and warm tallow poured into their cups. All slips, adaptor pieces and associated or spare gear, are surveyed at the same time as the cable. Finally, the shackles of cable are transposed as required, to avoid undue wear on any one length, joined up together and re-marked. The inner end of the cable is then made fast to the cable clench in the locker and the cable is stowed below.

OTHER MAINTENANCE

The King's Regulations and Admiralty Instructions require that capstans and cable holders be turned and lubricated weekly, and that their shafts and deck bushes be examined half-yearly and yearly. The yearly inspection involves lifting the capstans and cable holders. In addition, the arms of all anchors with movable flukes must be moved and lubricated monthly. *Form S.194* includes a statement that these requirements have been met.

HEAT TREATMENT AND TEST

This can be carried out only by a dockyard specially equipped for the purpose, and this item must be inserted in the ship's *Defect List* in time for it to be carried out when due. To avoid stretching the cables they are tested to only three-quarters of their proof load, but if any links have been renewed or extensively repaired the portion of the cable concerned is subjected to its full proof load. After testing every part is minutely examined.

The heat treatment of steel cable is somewhat different to that of iron cable and requires a higher temperature. Lugless joining shackles and anchor shackles being of nickel steel, cannot be heat-treated as with iron or forged steel cable, and so they are only tested. Spare swivels, lugged joining shackles, adapter pieces and other associated gear, are heat-treated with the cable only if they have been used.

MARKINGS ON CABLE

The manufacturer of the cable can be identified from the initials stamped on one side of the studs, and the year of the manufacture is stamped on the other side ; in forged steel cable these markings may be on alternate studs only. The links at the end of each length of cable are marked on one side with a broad arrow and the cable number, and on the other side with the number of the testing house certificate, the initials of the proving house, the proof load, and the initials of the overseer. Other cable gear is stamped in much the same manner.

A record of any heat treatment and retesting is also stamped on all lengths of cable and associated gear. For example, cable stamped AN.P.T. 9/48 T.40½ would have been heat-treated and tested to 40½ tons at Portsmouth in September 1948, the letters AN signifying annealed, *i.e.* heat-treated, and the second T signifying tested.

TESTS OF ANCHORS

Anchors are tested initially to a proof load given in their specifications, and if made of iron they are also fire-proofed. Fire-proofing is a process for detecting a flaw in the metal, or a bad casting. Anchors are not re-tested or again fire-proofed, except on completion of a large refit, unless considered desirable by dockyard officers.

MARKINGS ON ANCHORS

On satisfactory completion of the original test the proof load is stamped on the crown of the anchor, also the letter F if the anchor has also been fire-proofed (only iron anchors are fire-proofed). For example, an anchor marked T35TFC 9/48 would have been tested to 35 tons and fire-proofed, at Chatham, in September, 1948.

Anchors which have been examined, repaired, re-fire-proofed and so on are stamped on the shank as follows :—

- if examined, with E ;
- if fire-proofed, with F ;
- if repaired, with R ;
- if tested, with T, followed by the proof load.

The initial letter of the dockyard concerned is added to each. The letters REP indicate that the anchor has been repaired under special supervision.

PARTING OF CABLE

Should a cable part, the broken link should be recovered if possible and the fracture be covered with tinfoil or other suitable material to prevent rusting. It should then be forwarded to a southern naval dockyard if the ship is in home waters, or to the nearest naval dockyard if abroad, together with a detailed report on *Form S.541*.

ANCHORS SUPPLIED TO H.M. SHIPS

CLASS OF SHIP	DISPLACE- MENT IN TONS	NUMBER AND WEIGHT OF:		
		BOWER AND SHEET ANCHORS	STREAM ANCHORS	KEDGE ANCHORS (Admiralty pattern)
BATTLESHIPS				
<i>Vanguard</i>	44,500	two bowers each of 190 cwt. one sheet of 190 cwt.	one of 60 cwt.	one of 16 cwt.
<i>K.G.V.</i> class	35,000	two bowers each of 180 cwt.	one of 60 cwt.	one of 16 cwt.
AIRCRAFT CARRIERS				
<i>Fleet</i> class (<i>Illustrious</i>)	23,000	two bowers each of 160 cwt. one sheet of 160 cwt.	one of 60 cwt.	one of 16 cwt.
<i>Light Fleet</i> class (<i>Ocean</i>)	13,190	two bowers each of 160 cwt.	one of 60 cwt.	one of 16 cwt.
DEPOT SHIPS				
(<i>Tyne</i>)	11,000	two bowers each of 120 cwt. and one spare	—	one of 14 cwt. one of 10 cwt.
CRUISERS				
<i>Southampton</i> class ...	9,400	two bowers each of 100 cwt.	—	one of 12 cwt. one of 5 cwt.
<i>Fiji</i> class	8,000	two bowers each of 95 cwt.	—	one of 12 cwt. one of 5 cwt.
<i>Dido</i> class	5,450	two bowers each of 75 cwt.	—	one of 10 cwt. one of 4 cwt.
DESTROYERS				
<i>Battle</i> class	2,325	two bowers each of 42 cwt.	—	one of 5 cwt.
<i>Weapon</i> class	1,980	two bowers each of 36 cwt.	—	one of 5 cwt.
FRIGATES				
<i>Hunt</i> class	1,050	two bowers each of 22 cwt.	—	one of 5 cwt.
<i>Black Swan</i> class ...	1,470	two bowers each of 30 cwt.	—	one of 7 cwt.
<i>Loch</i> class	1,435	two bowers each of 30 cwt.	—	one of 7 cwt.
<i>Castle</i> and <i>Flower</i> classes	1,060	two bowers each of 22 cwt.	—	one of 5 cwt.
SUBMARINES				
"A" class	1,120	one bower of 12 cwt.	—	—
"T" class	1,090	one bower of 12 cwt.	—	—
"S" class	715	one bower of 8 cwt.	—	—

Note.—The particulars given in this table and the one opposite are subject to alteration, and are given only as a comparative guide to the anchor and cable outfits of different types of ships.

CABLES SUPPLIED TO H.M. SHIPS

CLASS OF SHIP	DISPLACE- MENT	SIZE OF CABLE	NO. OF SHACKLES	NO. OF HALF SHACKLES	TOTAL LENGTH OF CABLE
	<i>tons</i>	<i>in.</i>			<i>fm.</i>
BATTLESHIPS					
<i>Vanguard</i> ...	44,500	3 F.S.	28*	10*	495
<i>K.G.V.</i> class ...	35,000	2½ F.S.	35	10	500
AIRCRAFT CARRIERS					
<i>Fleet</i> class (<i>Illus- trious</i>)	23,000	2½ F.S.	36	11	519
<i>Light Fleet</i> class (<i>Ocean</i>)	13,190	2½ F.S.	28	10	412
DEPOT SHIPS					
(<i>Tyne</i>) ...	11,000	2½ F.S.	26	8	375
CRUISERS					
<i>Southampton</i> class	9,400	2½ F.S.	26	8	375
<i>Fiji</i> class ...	8,000	2 F.S.	22	8	325
<i>Dido</i> class ...	5,450	1½ F.S.	26	8	375
DESTROYERS					
<i>Battle</i> class ...	2,325	1 ⅞ F.S.	8*	7*	172
<i>Weapon</i> class ...	1,980	1½ F.S.	8*	7*	172
FRIGATES					
<i>Hunt</i> class	1,050	1½ W.I.	12	4	175
<i>Black Swan</i> class	1,300	1 ⅞ W.I.	12*	8*	210
<i>Loch</i> class ...	1,435	1 ⅞ M.S.M.Q. or W.I.M.Q.	12*	4*	210
<i>Castle and Flower</i> classes	1,060	1 ⅞ W.I.M.Q. or M.S.M.Q.	10*	2*	165
SUBMARINES					
" <i>A</i> " class ...	1,120	¾ W.I.	6*	—	90
" <i>T</i> " class ...	1,090	¾ W.I.	6*	—	90
" <i>S</i> " class ...	715	¾ W.I.	5*	—	75

Notes.—(1) Items marked * are supplied in 15-fathom lengths, the remainder are at present (1952) supplied in 12½-fathom lengths but will be replaced as opportunity offers by 15-fathom lengths.

(2) F.S.=forged steel; W.I.=wrought iron; M.S.M.Q.=mild steel, Merchant quality (iron test); W.I.M.Q.=wrought iron, Merchant quality.

ANCHOR WORK

Terms and Expressions used in Anchor Work

Shortening in Cable.—A ship lying at anchor is said to shorten in her cable when she heaves in part of it ; for example, a ship riding to eight shackles of cable might shorten in to three shackles.

Weighing Anchor is the operation of heaving in cable until the anchor is broken out of the ground and hove up clear of the water ; “ weigh ” must not be confused with “ way ”, as the latter refers to the motion of a ship through the water. The anchor is said to be “ a’weigh ” immediately it is clear of the bottom.

To Grow.—A cable is said to grow in the direction in which it leads outside the hawsepipe ; when asked how the cable grows the reply is given by pointing the arm in that direction, unless it grows vertically when the report “ Up and down ” should be given.

Short Stay.—The cable is said to be at short stay when it is taut and leads down at a steep angle to the anchor, and a bridle is said to be at short stay when the buoy is hove close under the hawsepipe.

Long Stay.—The cable is said to be at long stay when it is taut and reaches out well away from the hawsepipe and enters the water at an acute angle.

Up-and-down.—The cable is said to be up-and-down when it is vertical. When weighing anchor the cable will be up-and-down just before the anchor is broken out of the bottom, and this usually occurs soon after it is at short stay.

Clear or Foul Anchor.—The anchor is reported clear or foul as soon as it is entirely sighted. To be clear the anchor must be hanging from its ring, and clear of its own cable and of any obstruction such as a bight of rope or chain picked up from the bottom.

A’Cock-bill.—An anchor is said to be “ a’cock-bill ” when it has been eased out of the hawsepipe and hangs vertically by its ring.

Dragging.—An anchor is said to be dragging when, instead of holding the ship, the ship drags it along the bottom ; this may occur in heavy weather or in a strong current, especially if the holding ground is poor.

Anchor Coming Home means that the anchor is dragging towards the ship as the cable is hove in. When weighing, the ship should move up to the anchor, which should not break out of the bottom until the cable is up and down.

To Come-to.—A ship is said to have come-to as soon as she is riding by her anchor and cable. She is said to have “ got her cable ” when she has dropped back on her cable after anchoring and is riding by it.

To Veer Cable is to pay it out from the cable holder or windlass when these are connected to and controlled by their engines.

To Surge the cable is to allow it to run out by its own weight, or by the pull of its outboard end ; the cable holder being disconnected from the engine and with its brake off.

To Snub the Cable means to stop it running out by applying the brake.

To Range the Cable means to haul it out of the locker and range it in fleets ; on the fore’sle deck or the bottom of a dry dock, for example.

To Bring-to is to pass the cable, or a rope, round a cable holder, windlass, or capstan, for heaving it in or veering it.

To Bleed a Buoy is to bore a hole in it and drain out water that has leaked in.

Clear Hawse.—This term means that the cables are clear of one another when a ship is riding to two anchors.

Foul Hawse.—A ship has a foul hawse if the cables are crossed or otherwise foul of each other when she is riding to two anchors. If the ship swings 180 degrees she will have a foul hawse, and the cables are then said to have a "cross" in them; another 180 degrees more in the same direction would cause an "elbow" in the cables; a further 180 degrees would cause an "elbow and a cross", and yet another 180 degrees (making twice round in all) would cause a "round turn".

To Hang Cable is to hold it temporarily with a stopper.

A Hanger is usually a rope which is passed through a link of chain cable to hang it.

Anchoring

When the ship is at sea her anchors and cables are secured and lashed. The operation of preparing the anchors for letting go is called "clearing away anchors and cables", and this is done :—

- (i) when nearing harbour ;
- (ii) when approaching any land if the ship's position is uncertain ;
- (iii) in bad visibility if the depth of water permits of anchoring.

CLEARING AWAY ANCHORS AND CABLES

With a steam capstan notice for steam must first be given (about 20 minutes notice is usually required) and the cable party be piped to muster on the fore-castle. In a big ship this party would consist of :—

a chief stoker, stoker petty officer or electrician	for working the capstan engine ;
shipwrights	for working the cable holders ;
a blacksmith or shipwright	for handling the shackles and slips ;
seamen, preferably experienced men, their number depending on the size of the ship and cable	for handling the cable ;
a signalman	for displaying the cable flags ;
cable locker party, which, in a big ship, usually consists of Royal Marines	for stowing the cable.

In a small ship there will be no blacksmith, shipwrights, or Royal Marines, and the Chief Stoker works the capstan engine, clutch, and brake, the remaining duties being carried out by the seamen. Hands for the cable locker would be told off by the Captain of the Forecastle.

Sea lashings are cast off all gear, anchor stops removed, bonnets taken off the navel pipes, riding slips taken off or compressors eased off, covers removed from the cable locker and the cable cleared away ready for running out. The anchor is then eased down the hawsepipe by the screw slip, its weight being

taken on the Blake slip, to ensure that the anchor will not be held up by jamming in the hawsepipe. The sequence of orders for this operation, together with the action taken, is given below.

ORDER	ACTION
(i) " <i>Connect up port</i> " ...	The Chief Stoker manoeuvres the capstan engine to bring the special marks of the port cable holder in line, and a shipwright then engages the clutch.
(ii) " <i>Off brake port</i> " ...	The Shipwright takes off the brake.
(iii) " <i>Ease back the screw slip</i> "	The screw slip is started with a tommy bar and eased right off until the cable comes taut to the cable holder.
(iv) " <i>Heave in slow</i> " ...	The Chief Stoker heaves in with the engine until the cable holder takes the weight off the screw slip.
(v) " <i>Stop, off screw slip; on Blake slip slack</i> "	The screw slip and Blake slip are knocked off, and then the Blake slip is put on again after allowing sufficient slack for the anchor to be eased down the hawsepipe.
(vi) " <i>Veer port</i> " ...	The Chief Stoker veers the cable until the weight of the anchor is transferred to the Blake slip.
(vii) " <i>Stop. Disconnect port</i> " ...	The Shipwright disconnects the cable holder.

LETTING GO

At the order "*Stand by*" the hands below are warned to stand clear of the cable and the pin is taken out of the **Blake slip**; the shipwright or blacksmith then makes ready with his hammer to knock off the slip.

At the order "*Let go*" the shipwright stands by the brake and the slip is knocked off. The Cable Officer watches the cable outboard and directs the working of the brake so that the cable is laid out correctly. It must be laid out straight and clear along the bottom and never be allowed to pile up on itself; it must not be allowed to grow aft too tautly or the sharp nip in the hawsepipe may cause it to part. The way of the ship must always be stopped by her engines and not by the cable.

The task of the Cable Officer is much affected by the course and speed of the ship on letting go, both of which are controlled by the Captain; the speed while anchoring must be low, otherwise the cable will be unduly weakened by fatigue caused by the battering it will receive by running out too fast. H.M. ships normally anchor with headway still on the ship because they must let go in an exact position. If space permits they will let go on a course at right angles to the wind, current, or tidal stream, because then, as the ship drops back, she will have to drag a bight of cable along the bottom the effect of which will bring her up kindly to her anchor. If the ship anchors while steering down wind or stream a very heavy strain may be put on the cable when she is brought to her anchor and swings round to it. If anchoring up wind or stream the ship will drop back to her anchor when her way is checked, and the Cable Officer must then keep enough strain on the cable to pull the bight of it out straight.

When possible the weather anchor is always used so that the ship will swing clear of her cable. If about to anchor in deep water (say over 15 fathoms) the anchor is lowered to within about ten fathoms of the bottom before it is let go ; this is done to prevent damage to the anchor and cable.

SECURING CABLE

The cable must not be secured until the order to do so is received from the Captain on the bridge. On receiving this order the Cable Officer orders the cable holder to be connected, and adjusts the amount of cable out as ordered by the Captain. It is customary in the Royal Navy to secure the cable so that the joining shackle at the inboard end of the numbers of shackles of cable ordered to be out shall be just above the waterline ; if, for example, the Captain orders six shackles to be out the sixth joining shackle would be veered to the water line. There is, however, much to be said for securing with the joining shackle just abaft the Blake slip, because the cable can then be parted at this shackle and slipped quickly in emergency ; also, if two anchors are down, securing with the joining shackle in this position greatly facilitates clearing a foul hawse.

All H.M. ships fitted with a cable holder ride by the brake of the cable holder, with the riding slip or compressor acting as a preventer. To secure cable in this way, the riding slip or compressor is first put on, and the cable then veered slowly until just before it would be brought up taut by the slip or compressor. The brake is then put on, either by being screwed up hard or applied "brake to brake", according to the type fitted, the cable holder is disconnected, and the Blake slip is put on slack.

Under certain and very rare conditions a ship may have to get under way at a moment's notice. On such occasions she would ride by her Blake slip, with her cable broken abaft it and a buoy and buoy-rope bent to the outboard part. To get under way the cable is slipped and buoyed to be recovered later.

When cable has been secured a second anchor is always prepared for letting go.

Shortening-in and Weighing Single Anchor

As when clearing away, steam must be ordered on the capstan, the cable party piped to muster on the forecastle, and hands stationed at the cable locker. The appropriate cable holder is then connected, and the compressor or riding slip and the brake are taken off. Hoses are rigged and brooms provided for washing the cable as it comes in ; one hose is usually fitted with a nozzle and used to throw a jet of water on to the cable outboard, and a second hose without a nozzle is used inboard with the brooms. Paint is provided for marking the cable.

When ordered to shorten in, or to weigh, the Cable Officer gives the order to heave in. He must watch how the cable grows and indicate this to the Captain when required so that, if necessary, the ship's engines can be used to assist the capstan engine. If the cable grows sharply round the stem it must be hove in very slowly and with great care, because when subjected to such a bad nip the links may easily be strained and even part ; also, lugged shackles may foul the stem and open. Cable growing under the ship must be treated with similar care. As the cable comes in the mud on it is washed and scrubbed off by the cable party, the joining shackles are repainted, the wire strands marking the joining-shackles are renewed where necessary, and the hands below

see that the cable stows correctly in the locker. Cable which is not properly cleaned will soon advertise itself by its smell and should always be cleaned with particular care in tideless harbours with a muddy bottom.

"Up and down", "Anchor a'weigh", and "Clear anchor" are reported in due course to the Captain, and the anchor is then hove in and either secured or prepared for letting go again. Instructions for dealing with a foul anchor are given below.

SECURING ANCHORS AND CABLES FOR SEA

This must be done thoroughly or the anchors will work loose in a heavy sea, and it must be done quickly because the interval between the anchor being a'weigh and the ship reaching the open sea will often be short. The anchors must not be secured for sea, however, until ordered by the Captain, who, under normal conditions, will require both anchors to be ready for letting go until the ship is clear of the harbour.

To secure the anchor it is hove up carefully into its hawsepipe, the screw slip is put on and screwed up by hand, and the cable is then veered to the slip. The screw slip is then hove up as taut as possible with long tommy bars or a large spanner, and a short bar is lashed in place to prevent the slip from easing back on its thread; at the same time the cable holder is disconnected and the brake put on. All slips, compressors, and anchor strops are put on, and the cables are lashed together to prevent them from banging and chafing the deck as the ship rolls. The bonnets are replaced on the navel pipes, and their shutters are lashed to the cable and caulked in place with oakum. Finally, everything movable on the forecastle should be well lashed, or it may have to be secured later under difficult and dangerous conditions.

CLEARING FOUL ANCHOR

An anchor may come up foul of its own cable, or of a bight of rope or chain picked up from the bottom of the harbour. If foul of its own cable and the ship is stopped, it is best to let go the anchor again as it will then usually clear itself. If foul of a bight of rope or chain it is usually best to pass a hanger round the fouling bight and then veer the cable until the hanger takes the weight and the anchor comes clear, the anchor then being hove up and the hanger slipped.

Precautions in Bad Weather

If the ship is lying at single anchor, and if there is sufficient sea-room to leeward, cable should be veered to avoid the possibility of the anchor dragging. The cable holder must be connected while veering, because, if the cable were allowed to run out by the brake, the snatch on the cable caused by the weight of the ship suddenly coming on it after drifting astern and taking up the slack might break the anchor out of the ground. For additional security a second anchor may be let go, and then both cables veered.

Yawing.—A ship, especially one with a high forecastle, usually yaws considerably to each side of the wind when lying at single anchor in bad weather, (see Fig. 247). At the end of each yaw the ship is particularly liable to drag her anchor because she first surges ahead and then falls back on her cable, thus imparting a jerk to the anchor.

Such a yaw may be checked by veering the second anchor underfoot at the middle of the yaw and so that it just reaches the bottom. If, however, the weather is such that a second anchor is likely to be required for safety, it is

better to let it go at the end of the yaw and veer both cables so that the ship rides with one anchor at long stay and the other at short stay.

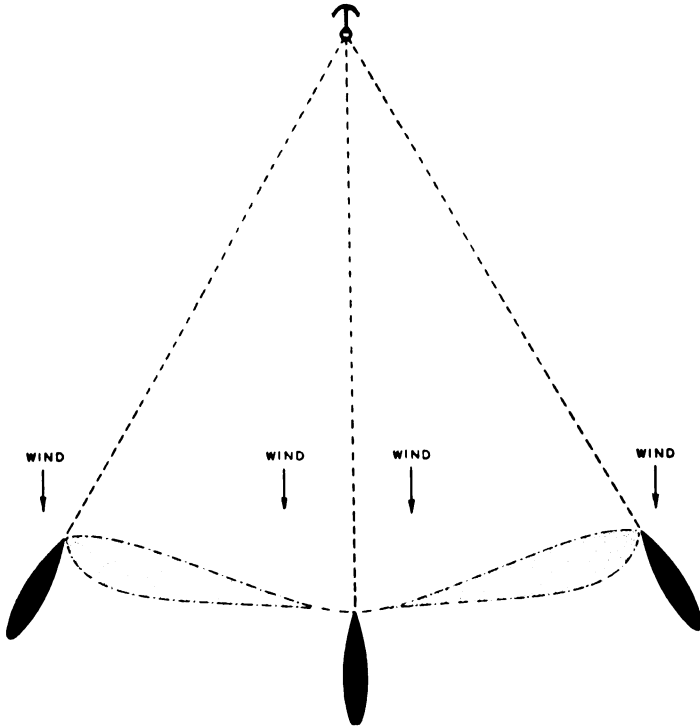


Fig. 247. Yaw of a ship at single anchor

Anchor Watch should always be set in bad weather. This watch consists of an officer stationed on the bridge, and a party of seamen stationed on the forecastle for watching and working the cable. Steam should be on the capstan and main engines, and the sea dutymen should be closed up at the wheel and telegraphs. Dragging of the anchor can be detected by taking frequent compass bearings of shore objects, by a hand lead lowered to the bottom, or by the behaviour of the cable. When the anchor is dragging, the cable usually tautens and slackens alternately in a marked manner and vibration can be felt in it as the anchor is dragged along the bottom.

Mooring Ship

A ship can be moored either with a "running moor", in which the first anchor is let go and the ship then continues to go ahead on her course to drop the second, or with a "dropping moor", in which the ship stops to let go the first anchor and then drops back on it to let go the second. The running moor is usually employed in the Royal Navy as it allows the ship to be moored accurately in a previously selected position. The amount of cable on each anchor of a moored ship should be not less than between four and five times the depth of water, and for a heavy ship a minimum of five shackles (75 fathoms) on each is usual.

RUNNING MOOR

To moor ship in a selected berth the intended position of each anchor is first marked on the chart. The line in which the two anchors are to lie is usually ordered by the senior officer present to conform to the direction of the prevailing wind or stream, and the anchors must be let go in such positions that the ship will be clear of danger when weighing them whatever the direction of wind or stream. The distance between the two anchors can be estimated as being equal to the sum of the amount of each cable out less the height of the hawsepipe above the bottom. If, for example, the hawsepipe of a ship is 18 feet above the waterline, and she moors in 10 fathoms of water with four shackles (60 fathoms) of cable on each anchor, the distance between anchors will be $120 - 13 = 107$ fathoms.

The ship approaches by steering along the line on which she is to let go her anchors, and the first anchor is let go in the pre-determined position by order given from the bridge ; if possible this should be the weather anchor so that the ship will swing clear of her cables when middling them. The second anchor is let go by order given either from the bridge or from the Cable Officer on the forecastle ; in the latter case it is let go when the amount of cable outside the hawsepipe on the first anchor is equal to the sum of the amount of cable intended to be out on each anchor after middling, less 10 to 12 fathoms ; for example, if mooring with four shackles (60 fathoms) out on each anchor, the second anchor is let go when between 108 and 110 fathoms have run out. This amount is not altered appreciably for the depth of water or the height of the hawsepipe above the water, the effects of these heights being largely counteracted by the fact that in the laying out the cables of each anchor their weight causes them to sag appreciably ; if mooring at low water when there is a large rise and fall, however, the second anchor should be let go early, by a distance equal to half the range of the tide. The earlier the second anchor is let go the slacker, of course, will be the moor, especially at low water.

For convenience it will now be assumed that the ship is mooring with five shackles out on each cable, that the cable holders can be worked by the capstan engine independently and that the second anchor is the port anchor and has just been let go.

As soon as the way is off the ship the starboard cable holder is connected and the starboard cable hove in, the port cable being allowed to run out a few fathoms at a time, under the control of the brake, so as to lay it out straight along the bottom. The cables must be middled so that the fifth joining shackle of each cable lies on deck abaft the slips. If the port cable is not laid out straight and taut its fifth joining shackle will be outboard before that on the starboard side is hove in ; on the other hand, if it is laid out too taut the port anchor may be dragged so that the moor will be very slack. The art of laying out a cable correctly is gained only by experience ; the general method is, by using the brake of the cable holder, alternately to allow a small amount of cable to run out and then snub it, each bight formed in the cable when it is run out being hauled out taut when it is snubbed so that the whole lies straight along the bottom.

When both cables are middled a slip is put on each, the brakes of both cable holders are put on, and the starboard cable holder is disconnected. Selection of the best slip for this purpose depends on the layout of the forecastle, but with a taut moor the screw slip is the most convenient, because it is before the Blake

slip and therefore obviates the heavy pull needed to get the joining shackle aft the last few fathoms to a position abreast the Blake slip. The screw slips are tested to half the proof load of the cable and are therefore strong enough to hold the ship under these conditions.

In a dropping moor the ship comes to with her first anchor, and when riding to the appropriate length of cable (80 to 110 fathoms if mooring with five shackles on each) the second anchor is let go. The cables are then middled as for a running moor.

Inserting the Swivel. The mooring swivel will have been placed alongside the riding cable abreast the fifth joining shackle.

(For convenience it is assumed that the ship is riding by the port cable.) The mooring swivel has two legs at each end, one of which has an odd number of links and the other an even number. The legs with the odd number of links are always joined to the starboard cable, and those with the even number to the port cable ; this serves to distinguish the cables when unmooring.

At the order " In swivel " from the bridge both cables are broken and the swivel inserted in the riding cable, which in this case is the port cable. The port cable holder is then connected and hove in to take the weight off the slip, and the brake is then put on and the cable holder disconnected. The mooring pendant is rove down through the port hawsepipe, up through the starboard hawsepipe, and secured to the inboard part of the starboard cable with a joggle shackle at three or four links from its end ; these links are then stopped to the mooring pendant. The starboard cable holder is now connected and the mooring pendant brought to the capstan. Then, by veering the starboard cable holder and heaving in with the capstan the inboard part of the starboard cable is hauled around the bows ; the capstan being of greater diameter than the cable holder it will heave faster than the latter can veer, and so the pendant must be surged frequently so as not to put too great a strain on it. When abreast the inboard end of the swivel the stops securing the links to the mooring pendant are cast off and the end link is shackled on to the appropriate leg of the swivel. The capstan is then veered until the weight of the starboard cable is taken, through the swivel, by the port cable holder, and the mooring pendant is then cast off and unrove.

The port cable holder is now connected, and the port slip is knocked off and hauled clear ; then, by heaving in on the starboard cable holder and veering on the port, the swivel is hauled round the bows and up through the starboard hawsepipe. When abreast the slip the remaining leg of the swivel is shackled to the outboard part of the starboard cable, and the starboard cable holder is hove in a bit further to take the weight of the starboard cable off the slip, which is knocked off and hauled clear. The swivel is then veered outboard until it is just above the water and the cables are secured.

It is usually possible to anticipate which will be the riding cable, and before entering harbour the swivel should be placed on the appropriate side and the mooring pendant rove and stopped clear of the cable. After mooring, the sheet anchor (if fitted) must be cleared away.

The strain on the cable of a moored ship in bad weather can be eased considerably by veering the swivel to the bottom, thus lessening the possibility of the ship dragging her anchors ; when this is done the swivel should be sighted daily if practicable.

Unmooring

A ship is unmoored by taking out the swivel, shackling the inboard and outboard parts of each cable together again, and then weighing one of the two anchors. The swivel is removed by reversing the procedure for inserting it, as described below.

Again assuming that, as is usual, both cable holders are driven off the capstan engine, both are now connected, one to heave and one to veer ; and, assuming that the ship is riding by her starboard anchor, the swivel is then hove inboard through the port hawsepipe. The outboard part of the port cable should now be put on the slip and then unshackled from the swivel, but if the parts lie awkwardly the slip can be put on the starboard cable instead, thus changing anchors ; (in either case a parting strop will probably be needed to separate the parts of the cable).

The swivel is then hove round the bow and up through the starboard hawsepipe, the slip is put on the outboard length of the starboard cable, and a hanger is rove on the inboard part of the port cable (which is still attached to the swivel). The starboard cable holder is then veered to transfer the weight to the slip and the hanger, and all parts are unshackled from the swivel. The two parts of starboard cable are then joined up and the swivel hauled clear. The hanger is then cut, thus allowing the end of the inboard part of port cable to run out and then be hove in its own side, but if the cable is heavy (above 2½-inch) it should be tailed with a rope and joggle shackle and eased through the hawsepipe. The port cable is then also remade by shackling the inboard and outboard parts together.

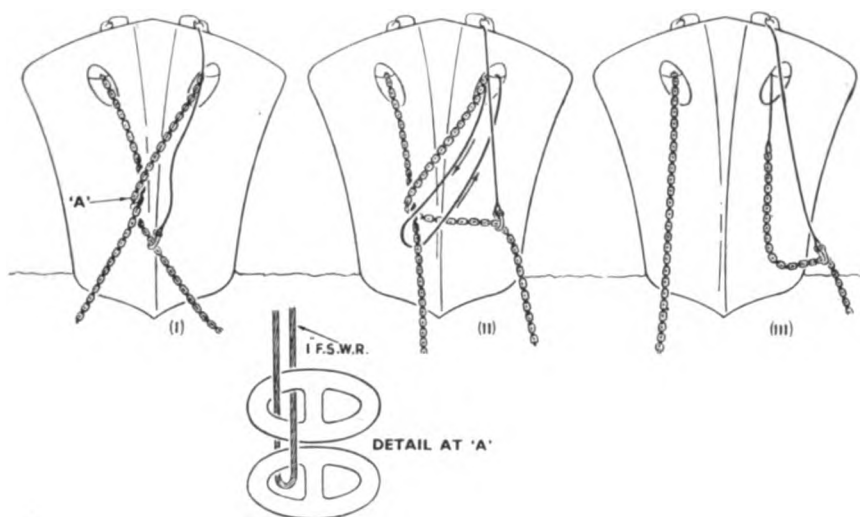
Weighing the First Anchor. The non-riding or lee anchor is always weighed first, by veering the riding cable and heaving in the non-riding cable until the lee anchor is aweigh. The lee anchor is then hove right in and either secured or prepared for letting go, and the riding cable is shortened in ready for weighing when ordered.

To Clear a Foul Hawse

The non-riding cable is hung outboard below the foul, then broken inboard, and the foul cleared by passing the freed end of the non-riding cable round the riding cable in the reverse direction to that of the turns ; only half a turn, however, should be taken out at a time. A detailed description of this operation is given below, in which it is assumed that the ship is riding by the starboard cable and that there is a round turn to be cleared.

If the turn is submerged the starboard cable is hove in to bring the turn to a convenient height above water, and the two cables are lashed together just below the turn to prevent the turn slipping down the cables. With heavy cable there is a danger that, when the lashing is cut after the hawse has been cleared, the two cables may spring back and injure whoever cuts the lashing. To obviate this possibility it is best to lash the cable by reeving a length of one-inch F.S.W. rope through the links, as shown in the inset in Fig. 248, and then to belay the two ends inboard, ensuring that the rope does not take the weight of the cable while the hawse is being cleared. The cables can then be unlashed from inboard by unreveing the rope.

A strong rope, such as the picking-up rope, is led outboard through the port hawsepipe or a convenient fairlead and attached with a joggle shackle to the port cable below the turn ; it is then brought to the capstan and hove in to



(I) PICKING UP ROPE SHACKLED TO NON-RIDING CABLE BY JOGGLE SHACKLE

(II) NON-RIDING CABLE HUNG BY PICKING-UP ROPE AND BROKEN INBOARD MESSENGER ROVE IN REVERSE DIRECTION TO CROSS AND SHACKLED TO END OF NON-RIDING CABLE

(III) END OF NON-RIDING CABLE VEERED ON MESSENGER AND CROSS CLEARED

Fig. 248. Clearing an elbow of a foul hawse
(inset : METHOD OF LASHING THE TWO CABLES)

take the weight of the cable. The port cable is hung inboard, or put on the screw slip, and then broken (the advantage of securing cable with the joining shackle on deck will now be evident). A rope, called the messenger, is now passed out through the port hawsepipe, dipped round the starboard cable in the opposite direction to the turn to be cleared, brought up again through the hawsepipe, and tailed on to the end of the outboard part of the port cable. The slip is knocked off and the messenger hove in ; if necessary the picking-up rope can be stoppered and the capstan used. If the cable is heavy (above 2½-in.) it is advisable not to let the end run out through the hawsepipe because of the battering it would then receive, but to ease it out by means of a rope fitted with a strop and toggle or any suitable slipping device. When half a turn in the cables has been cleared the messenger is stoppered, its end dipped again round the riding cable, and again hove in ; this will clear the remaining half turn. The end of the port cable is now hove back into the hawsepipe and the cable is joined up again. The picking-up rope is eased up and cast off, and the lashing is cut.

Securing to a Buoy

A ship is usually secured to a buoy with two bridles of cable, both of which are provided from one of her two bower cables, thus leaving the other anchor and cable ready for letting go if required. One bridle consists of a convenient length of cable detached from the bower cable, its inboard end being held by the Blake slip ; this is known as the "standing bridle". The other bridle is the remainder of the bower cable left rove round the cable holder, and is called the "working bridle".

The ship approaches the buoy with her bridles and picking-up rope ready for use. In a small ship the bridles lead through the bull-ring, but in a large ship they must pass through the hawsepipe, which necessitates catting one anchor. The picking-up rope can be taken through a separate fairlead, but the best lead is usually through the bull-ring, or hawsepipe, with the bridles. As far as possible neither bridles nor picking-up rope should be allowed to show outboard until just before reaching the buoy.

On arrival at the buoy a boat is used to make fast the picking-up rope to the ring of the buoy, one or two extra men known as "buoy jumpers" being carried in her for this purpose; these men must then be taken off the buoy as the ship heaves in the picking-up rope. When the buoy has been hauled close up to the stem the buoy jumpers man the buoy, and the ends of the bridles with their buoy-securing shackles are lowered to them and they secure the bridles to the ring of the buoy or to its reducing links; small ships usually put both the bridles on to the same link, as the buoy may have to be shared. Because the picking-up rope cannot haul the buoy close up under the hawsepipe or bull-ring, particularly if there is a strong wind or current, some means must be found to get the ends of the bridles sufficiently far forward to be lowered to the buoy. The ends of the bridles of small ships can be man-handled forward for this purpose; but those of large ships must each be triced up in a bight at a suitable position before the hawsepipe by means of a rope called a "bull-rope", the end of which is made fast to the bridle at two or three links from its end, and by means of which the end of the bridle is lowered directly to the men on the buoy.

When the bridles are shackled on, the picking-up rope is veered until they take the weight of the ship off the picking-up rope, which is then cast off, hauled inboard, and stowed away. No man should be allowed on the buoy while the picking-up rope is veered.

CATting THE ANCHOR

As when clearing away, the cable holder is hove in a little to take the weight off the screw slip; all slips are then knocked off and the anchor eased about one foot out of the hawsepipe. The catting pendant is now rove over the clump cathead, up through the hawsepipe, and secured to the ring of the anchor by the special catting shackle; it is then brought to the capstan so that it can be hove in as the cable holder veers. As in ships where the cable holders are driven by the capstan engine, the capstan heaves in faster than the cable holder veers, the catting pendant will have to be surged while transferring the weight of the anchor from the cable to the catting pendant, particularly during the initial stage of the operation and before much strain comes on it. The cable is therefore veered, and the pendant surged, until the anchor is just clear of the water; the pendant is then backed up and the anchor hove up to the cathead, where its weight is transferred to the special chain sling which is first passed through the ring of the anchor. Any slack in the cable is then taken down, the cable is put on the screw slip and broken at the half-shackle, and any spare cable is ranged neatly on deck.

TO PREPARE THE BRIDLES

The standing bridle is prepared and ranged first, followed by the working bridle. The cable holder is connected up, the cable is broken (in a small ship abaft the swivel, and in a large ship at the half-shackle), and a buoy-securing

shackle is shackled to its end. Sufficient cable to reach from the Blake slip nearly to the waterline is ranged on deck, and the Blake slip then put on it ; the best length for the standing bridle is found only by trial, after which it is usual to mark the link to which the Blake slip should be secured. The remainder of the shackle or the half-shackle is then ranged on deck, the cable is again broken, the second buoy-securing shackle is shackled to its end, and the working bridle is ranged so as to match the other for length.

The outboard ends of the bridles are ranged differently in large and small ships. In a small ship the end of each is passed a few feet through the bull-ring and neatly laid back inboard, and on approaching the buoy the end is run out through the bull-ring so that its shackle hangs just above the water.

In a large ship the outboard ends of the bridles are placed in the hawsepipe and temporarily hung there. The bull-ropes are rove out through the bow fairlead, up through the hawsepipe, and then secured to their bridles at the second or third link from the buoy-securing shackle ; the bull-ropes are usually tailed at their inboard ends by small tackles. On approaching the buoy the bridles are started so that they run out through the hawsepipe and hang down in a bight with the outer end held by the bull-rope at the second or third link ; the height of the bight above the water can then be adjusted by the tackle tailed to the end of the bull-rope.

The bolt of a buoy-securing shackle should always be fitted with a lanyard secured to the shackle or tended inboard.

SENDING THE PICKING-UP ROPE TO THE BUOY

Each ship has her own method of sending the picking-up rope to the buoy ; the principles involved in the four usual methods are described below. Whenever part of the picking-up rope is taken in a boat, the end with the hook and and stop attached must be passed in to the headsheets with sufficient slack for the buoy jumpers to make it fast to the buoy ; when all the rope is in the boat, the remainder must be coiled clear for running in the sternsheets. The picking-up rope is always made fast by passing the strop *up* through the ring or reducing link of the buoy and then placing it on the spring hook.

First Method.—A heaving line is bent to the picking-up rope and taken in the boat to the buoy ; the picking-up rope is then hove out by the buoy jumpers and made fast to the ring of the buoy ; it is important not to pay out more than the buoy jumpers can comfortably handle. This method is very quick but requires the ship being brought close to the buoy.

Second Method.—The end of the picking-up rope is passed into the bows of the boat and the bight is held by a hanger or chain check stopper secured aft in the boat ; the boat then makes for the buoy. The distance that can be reached by the boat will be increased if a few fathoms of the picking-up rope are coiled down in the sternsheets ; then, when further headway becomes difficult, this slack rope is eased out by means of the chain check stopper, thus enabling progress to be continued. It is important to head correctly for the buoy in the first place, due allowance being made for wind and stream, because once away from the ship the heavy bight of picking-up rope astern of the boat prevents her from altering course.

Third Method.—The end of the picking-up rope with its strop and hook is passed down as before and then followed by all the remainder ; alternatively the entire picking-rope is placed in the seaboard when at the davit

head. The boat goes to the buoy towing a grass line only, and on arrival the picking-up rope is made fast to the buoy and the other end tailed to the grass line. The hands in the boat then get down clear, usually below the thwarts, and the picking-up rope is run in on the forecastle by means of the grass line. This method allows the picking-up rope to be sent and secured to the buoy while the ship is still at a considerable distance from it, as may sometimes be necessary in confined waters or with an adverse wind, but it involves a waste of time if the ship can come close to the buoy.

Fourth Method.—The boat takes one end of each of two grass lines to the buoy, and her crew reeve one of them through the ring of the buoy and bend it to the other. Hands on board the ship then haul the picking-up rope out to the buoy by means of the grass lines, and the buoy jumpers from the boat secure it to the ring or link of the buoy.

Whichever method is used the boat should be lowered in plenty of time to ensure that she gets to the buoy well in advance of the ship; when using a pulling boat she is usually given a good start by hauling her rapidly ahead on a boat-rope immediately she is slipped. The coxswain must be careful never to let his boat get between the ship and the buoy, or across a tautening picking-up rope; and whenever lying off, while the ship heaves in the picking-up rope, for example, he should always keep his boat pointed at the buoy ready to go alongside it again instantly when called. Men should always wear life-jackets while on the buoy; life-lines should only be worn with great discretion, as there is a danger of their fouling the buoy and pulling the men underwater.

Securing Head and Stern to Buoys

Here again each ship has her own methods, and the best way to approach depends on wind and stream. The ship is secured to the head buoy in the manner already described, but a second picking-up rope must be sent from aft to the stern buoy. After shackling on the bridles forward they must be veered out, by a considerable amount if the berth is for a longer ship than your own, so that the ship can be dropped astern and secured to the after buoy. This done the bridles are hove in to middle the ship between the two buoys, and then secured. The method usually adopted for veering the bridles is to break the cable on the anchor kept ready for letting go and tail it on to the standing bridle, the slack then being taken down and both bridles veered together; an alternative is to hang the standing bridle at its normal length and put on the Blake slip so as to allow a very long scope; when the bridles have been shackled on, the hanger is cut so that the standing bridle runs out to the Blake slip. The remainder of the operation with the working bridle is then carried out, and the standing bridle, which is hanging slack, is then hove in and secured as convenient.

Slipping from a Buoy

A slip-rope is rove between the ship and the buoy, so that the bridles can be cast off and the ship held by it until the order is given to slip.

The slip-rope is a length of wire rope fitted with a soft eye at one end. It is rove out through a convenient fairlead, *down* through the ring of the buoy so that it will be unlikely to foul it when slipped, then in through another fairlead,

put on to a slip, and then hauled taut by hand and belayed. The slip-rope must be rove so that it will not jam, or be jammed, by the bridles.

Taking off First Bridle.—The usual method is to take off the working bridle first ; this is done by veering it, unshackling it from the buoy as soon as there is enough slack, and then heaving it in and tailing it on to the inboard end of the standing bridle after removing the buoy-securing shackle. When the bridle is long its weight will have to be taken off the buoy-securing shackle before it can be unshackled ; there are different ways of doing this, a simple one being to reeve a hanger from the ring of the buoy to a conveniently near link of the bridle ; the hanger will then take the weight of the bight as the bridle is veered.

Taking off Second Bridle.—The weight of the ship is transferred to the slip-rope, either by belaying the slip-rope and veering the remaining bridle, or by bringing the slip-rope to the capstan and heaving it in while veering the bridle ; the latter method is quicker and keeps the buoy steadier, and so is more suitable in bad weather. When slack the bridle is unshackled and hove in.

The weight must not be taken on the slip-rope, or the second bridle be removed, until orders are received from the Captain, which will be when steam is on the main engines and the special sea duty men are closed up.

To Slip.—The turns of the slip-rope are surged and cast off the bollard or capstan, and the slip on the eye is knocked off ; the rope is then run in by hand. If there is much weight on the slip when it is knocked off it will probably jump up and may injure whoever knocks it off ; it is therefore always advisable to ease off the strain on the slip before knocking it off, but if this is not practicable see that everyone stands well clear when it is knocked off.

Weighing by Deck Tackle

This method of weighing anchor can be used if the capstan engine breaks down, and though not usually so effective as working the capstan by hand it is the only alternative available in many ships today. The deck tackle is usually a large three-fold purchase, its actual size depending on the size of the ship. In destroyers and smaller naval vessels this tackle is supplied and kept rove ; but in larger ships it is rove only when required, as its fall consists of one of the outfit of manila hawsers.

When rove the standing block of the tackle is secured to a special deck clench fitted as far aft as possible on the forecastle, and the moving block is made fast to the cable with a joggle shackle. As long a scope as possible is obtained between the blocks, but the moving block must be kept clear of obstructions. For example, when weighing the starboard anchor it may be necessary to introduce a short pendant between the block and joggle shackle to clear the sheet cable (see Fig. 249) ; this reduces the scope but must be accepted.

Handspikes are provided for steering the moving block clear of obstructions and preventing the tackle from twisting. When all is ready the fall is manned and hauled away until the tackle is two blocks ; the weight of the cable is then taken on the screw slip, the joggle shackle removed, and the moving block hauled forward as the tackle is overhauled ; with very large deck tackles a special overhauling tackle must be rigged (see Fig. 249). The joggle shackle

is again put on the cable and a further fleet hauled in, this operation being repeated as often as required.

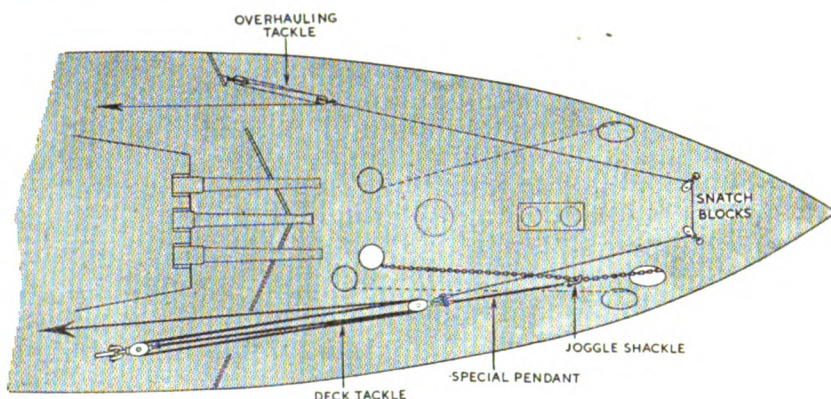


Fig. 249. Weighing by deck tackle

Pointing Ship

In an anchorage where there is little or no current or tidal stream, and in reasonably calm weather, a ship may be pointed to lie at an angle with the line of her cable by putting a spring on her cable as described below.

First heave in a shackle or so of cable. Now lead a heavy hawser out through the aftermost quarter fairlead and thence forward and outboard of all, and shackle it with a joggle shackle to the cable outboard of the hawsepipe, thus forming the spring. Then belay the hawser and veer the cable, and the ship's head should pay off away from the side on which the spring is rove until pointing in the required direction, when the cable should be secured. It may be necessary to use the rudder to give the ship an initial cast in the required direction.

Slipping by the Stern from a Buoy

In a crowded anchorage where there is little room for manœuvring it may be necessary before slipping from a buoy to point the vessel in a direction other than that in which she is lying. This is done by reeving an additional slip rope, from the quarter fairlead, outboard of all, through the ring of the buoy and then back through another quarter fairlead, and then putting the eye on a slip. The ship is then given a cast in the required direction, the head slip-rope being surged as necessary and any slack in the after slip-rope being taken down. The head slip-rope is then slipped and run in, and, when the ship is pointing in the required direction, the after slip-rope is slipped and run in.

CHAPTER X

Laying Out Hawsers and Anchors, Towing, and Target Work

LAYING OUT HAWSERS AND ANCHORS

Laying Out Hawsers

A HAWSER is usually laid out to warp or kedge the ship from one place to another, or to hold her temporarily in a certain position. The method of laying out a hawser by boat depends upon the type of boat available, the size of hawser, the distance to which the hawser has to be taken, and the strength and direction of wind and current or tidal stream and their direction relative to the intended line of the hawser.

If the hawser is to be laid out up wind or stream it is best to take the entire hawser in the boat to the position at which its end is to be made fast, and then pay it out over the stern of the boat as she returns to the ship. A fibre hawser would be coiled down in the sternsheets, but a wire hawser would be embarked reeled upon its reel, which must be securely lashed in the sternsheets. A three-inch or larger wire hawser should be paid out under the control of a chain check stopper, rove as illustrated in Fig. 250. If the hawser is too bulky or heavy to be carried in the boat it can be hauled out to the required position on a messenger laid out by the boat.

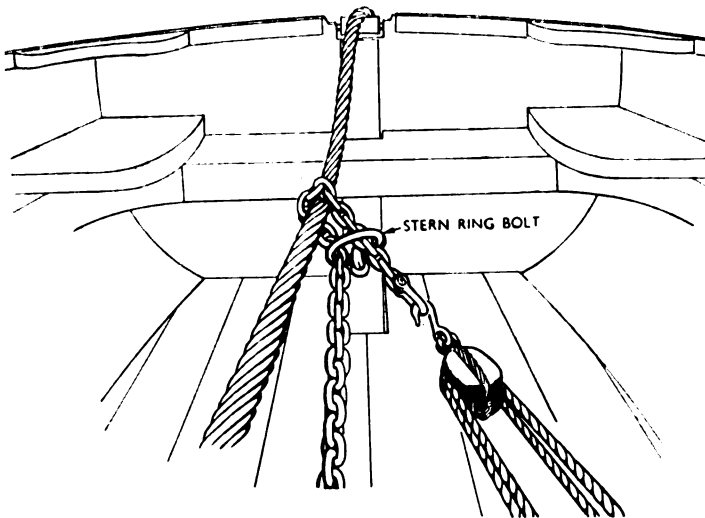


Fig. 250. Method of stoppering a hawser in a boat

If the hawser is to be laid out down wind or stream the end is secured in the headsheets of the boat, a few fathoms are coiled in the sternsheets, and the bight is securely stoppered by a fibre or chain stopper secured to the after sling keel plate. The boat then proceeds to the position to which the hawser is to be taken, the bight being paid out from the ship.

If a fibre hawser is to be laid out across wind or stream a few fathoms of it should be coiled down in the headsheets, and a further length, equal to about half the distance to be covered, should be coiled down in the sternsheets with its bight stoppered. The boat then steers to the required position, making due allowance for leeway, while the bight is paid out from the ship, and when she has covered well over half the distance she pays out the length coiled down in her sternsheets as she covers the remaining distance. If the position to which the hawser is to be laid out is some distance away another boat may be used to under-run and support the bight ; the bight should be hung from the stern and not laid across the boat, and the boat should head up wind or stream.

If a wire hawser is to be laid out across wind or stream it is best to take it in the boat reeled up on its reel, and then secure the end at the required position and pay it out over the stern of the boat while returning to the ship. When proceeding with the hawser to the required position sufficient allowance for drift or leeway must always be made in the course steered, because the boat will be unable to make good any leeway while dragging the heavy bight of the hawser against wind or stream.

Laying Out Anchors

An anchor is usually laid out to prevent a ship which is anchored or moored from swinging towards some obstruction or in an undesired direction, or to kedge a ship from one position to another. The method employed depends upon the size of the anchor, the size of the boat or boats available, and the depth of water in which the anchor is to be laid. Four typical methods are described here as a general guide.

TO LAY OUT A LIGHT ANCHOR

First Method (Fig. 251).—The anchor is slung from the stern of the boat, the rudder having been unshipped. The anchor is hoisted out on the fall of a davit, and then lowered into the water and transferred from the davit fall to a special sling secured in the boat.

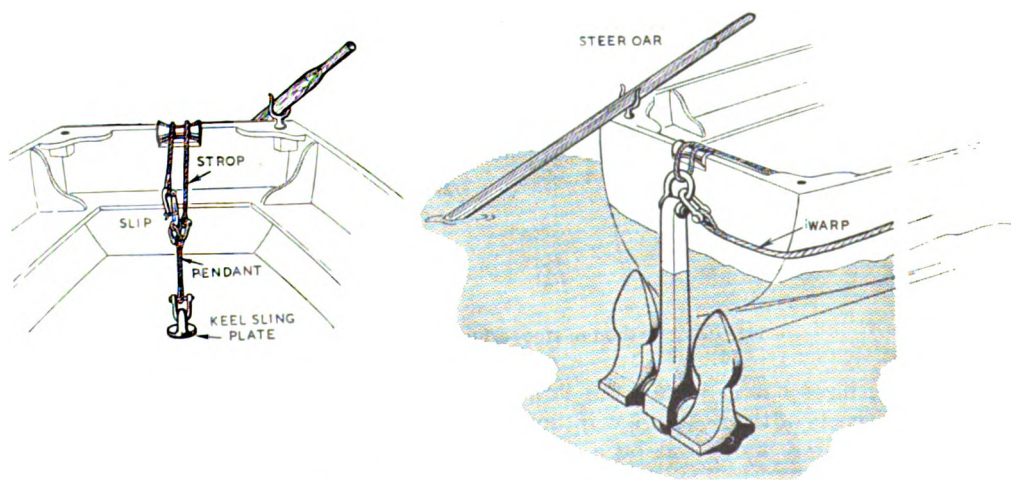


Fig. 251. A light anchor slung over the stern of a boat

The sling of wire rope is fitted and rove as shown in Fig. 251, but if an Admiralty pattern anchor is used the sling may be rove round the shank and under the stock instead. If a fitted wire rope sling is not provided the anchor may be slung by a cordage lashing, or a strop and toggle. If an uncomfortable sea is running it may be advisable to hoist the boat clear of the water before slinging the anchor over her stern, otherwise the boat may be stove in by the flukes of the anchor as the latter is transhipped. The end of a suitable wire hawser, called the "warp", is shackled to the ring of the anchor, and the reel is lowered and secured in the boat. A buoy-rope, of sufficient strength to weigh the anchor and equal in length to more than twice the depth at high water, is rove through a block shackled to the crown or the gravity band of the anchor, and both ends are then bent to the anchor buoy.

A steer-oar is shipped over the stern and the boat is then pulled or towed to the position where the anchor is to be let go, which should have been determined previously by transits or bearings of fixed objects. The actual depth of water is ascertained by sounding, and the buoy and buoy-rope are streamed. Then more than sufficient rope for the depth of the water is pulled off the reel and streamed over the bows, and the bight of the rope is stoppered. The anchor is then let go by knocking off the slip, or slipping the toggle, or cutting the lashing by which it is slung.

To weigh the anchor the buoy and both ends of the buoy-rope are recovered into the boat. One end of the buoy-rope is bent to the sling plate of the after sling and the other is hauled on by the boat's crew. To break the anchor out of the bottom it may be necessary to clap a luff on to the hauling part of the buoy-rope, with its standing block hooked to the foremost sling plate.

Second Method (Fig. 252).—The anchor is slung by its gravity band, or by a strop on the shank at its point of balance, and lowered on to three capstan bars or spars laid across the stern and quarters of the boat. The shank is lashed to the ringbolt of the after sling and the ring of the stock is lashed to the keel plate of the after sling. The remainder of the gear is provided and rigged as in the first method.

The anchor is let go by cutting the lashings and canting the capstan bars, thus allowing it to slide down them and over the stern of the boat.

This method cannot be used with a motor cutter because of her Kitchen rudder, but, with certain modifications, the gear can be similarly rigged over the headsheets of the boat so that the anchor can be slid over her bows.

TO LAY OUT A HEAVY ANCHOR

First Method (Fig. 253).—In this method the anchor is slung below the boat on a special three-legged sling fitted with a rigging slip.

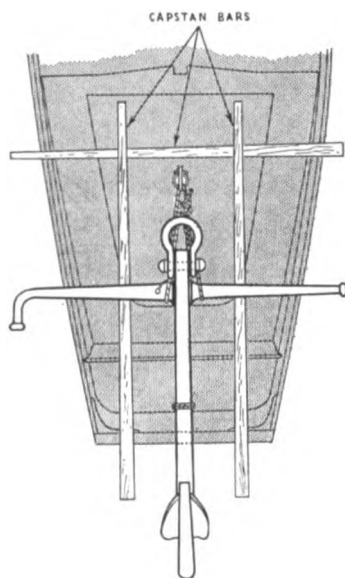


Fig. 252. A light anchor stowed over the sternsheets of a boat

The boat is fitted with its strongback ; the span of the anchor sling is then rove under the boat and over the strong back, and the leg of the sling is stopped to the gunwale. The boat is then brought round and made fast abaft the position from which the anchor is to be lowered.

When laying out a bower anchor the cable is broken abaft the swivel piece. A special pendant of wire rope, called a "ganger", is shackled to the swivel piece ; the other end is shackled to the mooring pendant, and the latter is brought to the capstan. The weight of the anchor is then taken on the mooring pendant, the screw slip is knocked off, and the anchor is lowered to the water. The purpose of the ganger is to provide a pendant to reach from the ring of the anchor to the gunwale of the boat when the anchor is slung beneath her.

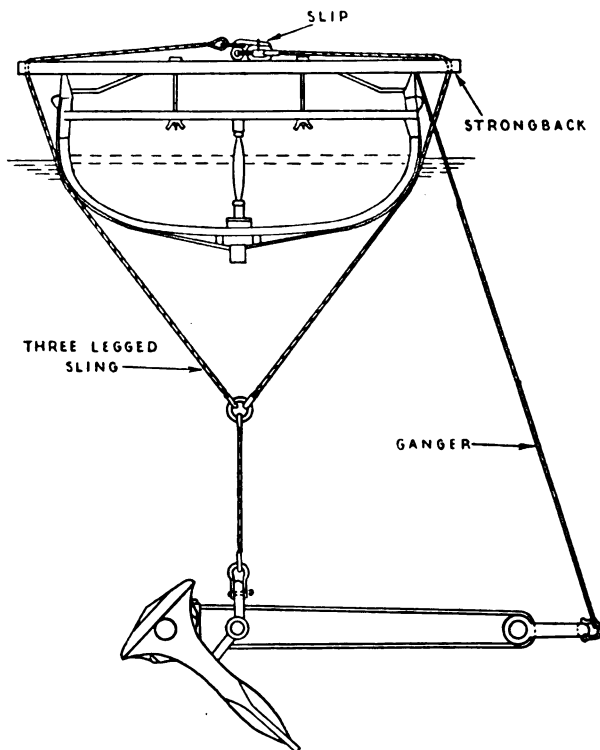


Fig. 253. A heavy anchor slung below a boat

When the anchor is awash the boat is hauled forward and the leg of the sling shackled to the gravity band of the anchor ; at the same time a buoy-rope is either bent to the shank or rove through a block shackled to the gravity band. The anchor is then slowly lowered until the boat gradually takes its weight, care being taken to keep the slip of the slings amidships, for which the use of a small jigger may be necessary. The ganger is then securely stopped to the gunwale with a stout hanger, and the mooring pendant is unshackled.

The hawser to be used for the warp is flaked down in another boat. Its first eye is secured to the after sling keel plate and the hawser is flaked down on the thwarts, the turns being passed round inside the boat close to her sides and each flake being secured by stops to each bow and quarter ; in addition,

each flake is secured to the forward ringbolt by a long hanger rove with a complete turn round the bight of the hawser. The last length of the hawser, which must be greater than the depth of water in which the anchor is to be laid, is passed round the outside of the boat, the turns being hung by stout strands secured inside the boat ; the end is passed to the boat from which the anchor is slung, and there shackled to the ganger.

The veering of the hawser from the boat is controlled by a chain check stopper, rove as shown in Fig. 250, the hauling end of which is hooked to a jigger whose standing block is shackled to the forward sling keel plate.

The boat with the warp is towed by the boat with the anchor to the position in which the anchor is to be let go. A sounding is taken to check the depth of water and when both boats are in position and all is ready the anchor is let go. As heavy wire hawsers are dangerous if allowed to take charge, every precaution must be taken to ensure that the hawser is under control while being veered from the warp boat. All the crew are ordered below the thwarts, the chain check stopper is bowsed down, and the stops holding the outer turns of the warp are cut. When these turns are seen to fall clear of the boat the anchor buoy is streamed from the other boat and the anchor is let go by knocking off the slip of the slings. The warp boat is then towed back to the ship, or wherever the end of the warp is required, the warp being payed out as necessary. When paying out the warp the stops of each flake are cut successively, and the bight of each flake eased aft by its long hanger and controlled by the chain check stopper.

If the anchor is sufficiently light it may be weighed in the boat by means of its buoy-rope, or its warp, by using two luffs alternately, each being shackled to the ringbolt of the foremost sling. To break the anchor out of the bottom it may be necessary to use luff upon luff.

If, as is often the case, the anchor is too heavy to be weighed in the boat the buoyancy of the boat can, in tidal water, be used to break it out of the bottom on a rising tide, and it can then be transported back to the ship for weighing. To do this the boat is fitted with its strongback and placed over the anchor at low water, and the two parts of the buoy rope (if of sufficient strength) are hauled taut over the strongback and secured together by bulldog grips. As the tide rises the buoyancy of the boat should then break the anchor out, and the boat with the anchor slung beneath it can then be towed to the ship. A hammer and chisel, or wire cutters, should be ready at hand to cut the buoy-rope if it appears that the buoyancy of the boat is insufficient to break the anchor out.

If the buoy-rope is not strong enough to break the anchor out, the boat must be fitted with a sling and a diver be sent down to shackle to it a leg of the sling already on the anchor ; the total length of the two slings must be adjusted to the depth of the water at low tide.

Second Method (Fig. 254).—The first method is not practicable if the anchor is to be laid in shallow water, so then it is slung between two boats.

A spar of sufficient strength is securely lashed across the gunwales of the two boats, and well shored and chocked inside them so as to distribute the weight evenly and protect the gunwales from being crushed by the weight of the anchor. A lighter spar is lashed across the stern sheets of both boats to keep them from diverging or converging when in tow, and to support the ring

of the anchor. The anchor is slung from its gravity band to the heavy spar by a strop and toggle, a lashing, or a pendant and slip.

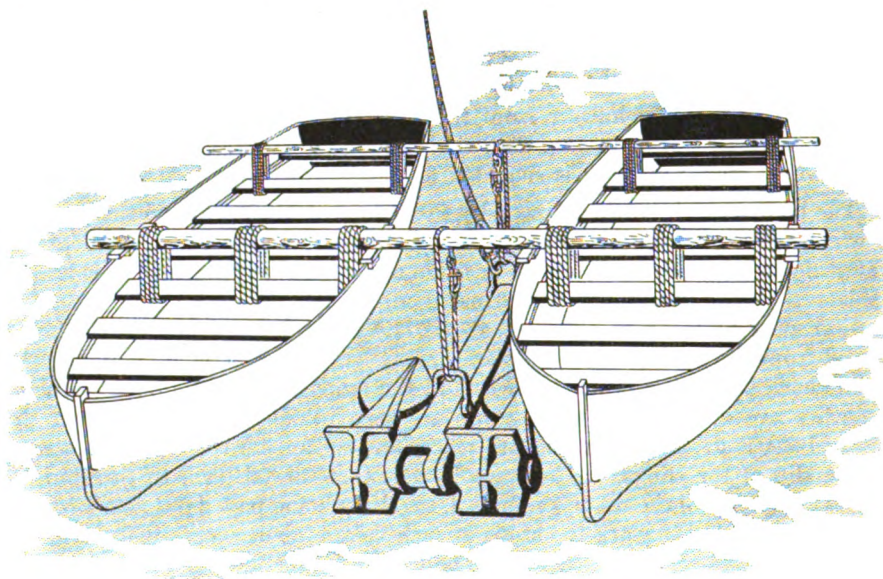


Fig. 254. A heavy anchor slung below two boats

Two cutters (the tons per inch immersion each of which is approximately half a ton) should be capable of carrying a six-ton anchor in this manner, while leaving them a freeboard of from 18 to 20 inches.

If the boats are lashed about two feet apart the diameter of the large spar should be nine inches for a six-ton anchor. This diameter may be decreased by half an inch for every ton decrease in weight.

TOWING AND TAKING IN TOW

A ship should always be prepared at short notice to take another in tow, or to be taken in tow herself, either from forward or aft. All warships are equipped for towing or being taken in tow, and here only the standard arrangements for which provision is made in H.M. ships will be described. Other methods of towing are described in Volume III of this manual.

Towing Hawsers

The larger warships are provided with two towing hawsers of E.S.F.S.W.R., one usually of smaller size than the other and the size of each depending upon the size of the ship. As a ship usually tows or is towed by one hawser only, her larger hawser is usually stowed on a reel at the after end of the forecastle, and the smaller hawser on a reel at the forward end of the quarterdeck.

A wire rope being very light for its strength, but not very elastic, it is usual to join the tow-rope to the cable of the ship being towed, which then veers a shackle or more of her cable so that its weight will act as a spring on the tow-rope and damp down the force of any sudden strain. A ship may be towed with

the tow-rope led through the hawsepipe, or through one of her foremost fairleads, or, if she is a small ship, through her bullring. A swivel piece may be inserted at one or both ends of the towing hawser, but opinions differ as to whether a swivel piece is necessary with wire hawsers.

Some small ships, tugs, and small vessels use manila hawsers as tow ropes ; these make good tow-ropes because they are far more elastic and more easily handled than wire hawsers, but they should be cable-laid and not hawser-laid. Cable-laid rope does not tend to lay up or unlay itself when under strain and is more flexible and water-tight than hawser-laid rope. A hawser-laid rope, on the other hand, has a tendency to twist because its strands act as screw threads and so the rope is twisted by the water when towed through it ; when under strain the rope tends to unlay, and when the strain is removed the natural resiliency of the rope causes it to snarl into kinks and twists. If a hawser-laid manila hawser is used for towing, swivels should be inserted at each end of the tow-rope.

Towing Arrangements

The tow should be capable of being slipped at a moment's notice in emergency, and provision for this is made in the towing ship by securing the tow-rope on a special towing slip.

The arrangements in warships for towing aft are shown in Fig. 255. In a destroyer the tow-rope is secured to a hinged slip fitted at her stern ; as this slip will not take the eye of a large hawser a special towing shackle, long in the clear, should be sent over with the hawser. A cruiser tows from her after bollards, which are specially strengthened for the purpose and are much stronger than those of a battleship. A battleship tows from her after barbette. The anchorage for the towing pendants for cruisers and battleships is a special deck clench fitted respectively before the bollards and on the forward side of the barbette. The size of the pendants is the same as that of the largest hawser.

It will be noticed that no provision is made for freshening the nip of the tow rope in the fairleads, nor can the towing ship shorten or lengthen the tow. If a ship is to be towed a long way the fairleads should be packed with wood or other material to lessen the chafe, and the rope should be served with rounding where it passes through the fairlead ; alternatively, the tow-rope can be secured to a length of cable, which will better withstand chafe. Normally the length of tow is adjusted in the towed ship, but this can be done in the towing ship by shackling another hawser to the tow-rope and belaying it to bollards abaft the barbette or before the towing bollards ; if done in the towing ship, however, the tow cannot be slipped at a moment's notice in emergency. If the tow has to be shortened by the towing ship the towing hawser itself must be taken round the barbette or to the towing bollards and then belayed to other bollards, and again the tow could not be slipped suddenly in emergency.

Preparations for Towing

The preparations for towing or being taken in tow vary with the type and size of the ship and the layout of her forecastle, quarterdeck and upper deck. The size of the hawser to be handled also has a bearing on the extent of the preparations, because a heavy hawser must first be unreeled and then flaked or ranged in such a manner that it will be under full control when veered. As

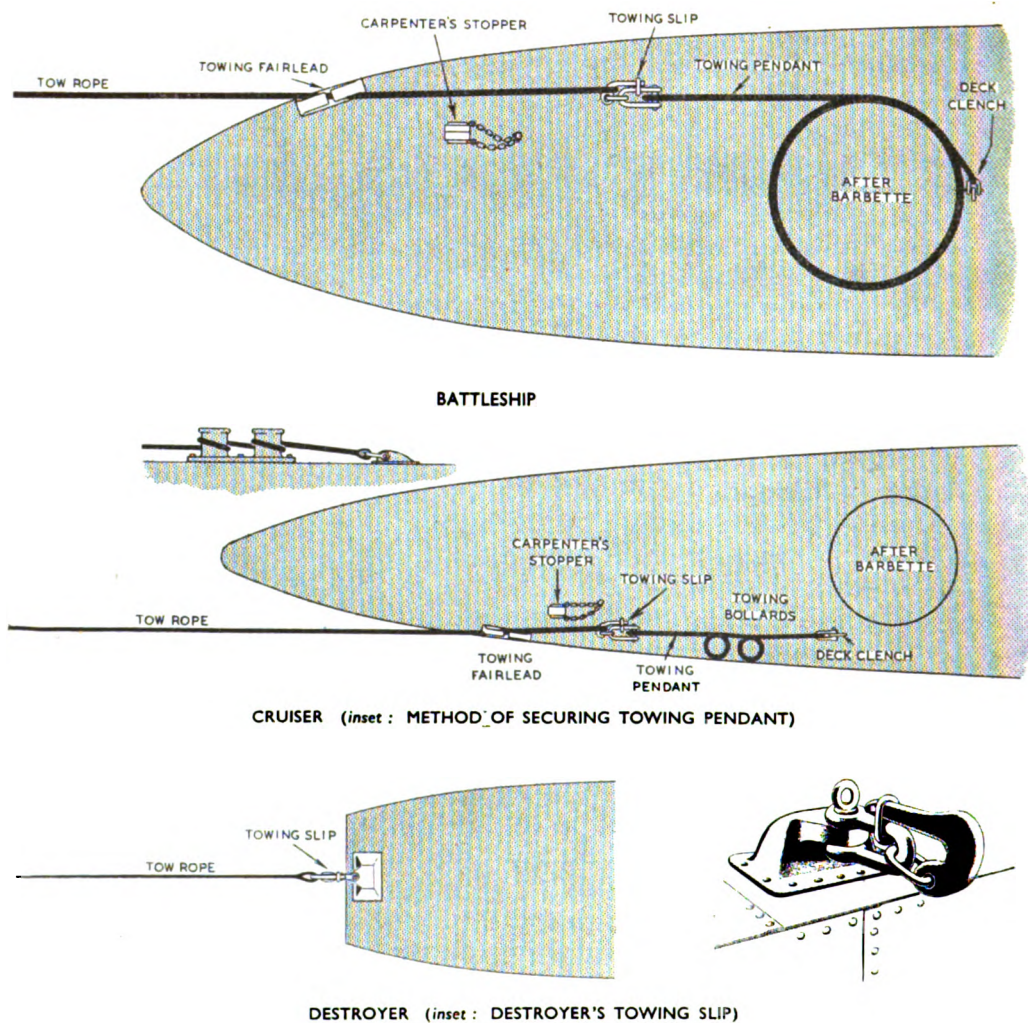


Fig. 255. Towing arrangements in warships

an example, typical arrangements in a cruiser for being taken in tow and for towing are described below and illustrated in Fig. 256.

Preparations in the Ship to be Towed.—Whenever practicable the ship to be towed should provide the hawsers and messengers, because when the tow is slipped it is easier for her to recover the tow with her cable gear. The towing ship also, however, should always be prepared to provide the hawsers and messengers.

The port cable of the ship to be towed is broken abaft the swivel piece and the spare swivel piece is shackled to its end. The guard rails over the foremost fairleads are slipped, the "panama plates" (i.e. the plates bolted across the top of the fairleads) are removed from the fairleads, and the jackstaff is unshipped. A Carpenter's stopper is provided abaft the port foremost fairlead.

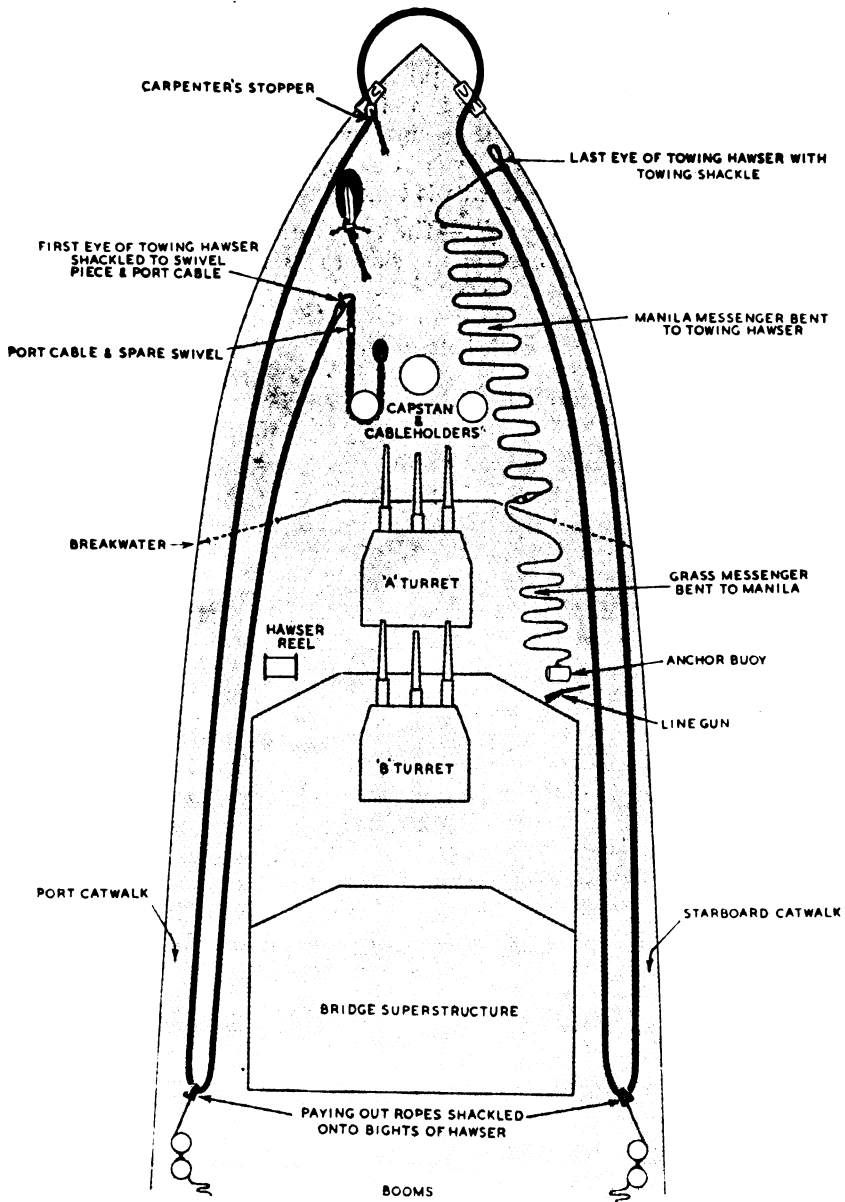


Fig. 256. Preparations in a cruiser for being taken in tow

The first end of the towing hawser is taken from the reel and shackled to the swivel piece. The bight is then led aft along the port catwalk to the boat deck, where a small paying-out rope is shackled on to it with a bow shackle. The bight is then led forward and dropped over the stem with its two parts in the bow fairleads, and the Carpenter's stopper is put on the port bight. The bight is then led aft along the starboard catwalk to the boat deck where another paying-out rope is shackled on to it. The last end of the hawser is unrove from

the reel and placed abreast the starboard bow fairlead, and a towing shackle is shackled to it and stopped securely to its eye.

A manila and a grass hawser are provided as messengers. The manila is flaked down abreast the bow fairlead, and the grass is flaked down abaft it. The first end of the manila is hitched securely with a rolling hitch to the towing hawser just below its eye, and the eye of the hawser is securely stopped to the manila. The other end of the manila is bent to the first end of the grass.

Preparations in the Towing Ship.—The preparations in the towing ship are not nearly so extensive as those in the ship to be towed, unless she has to provide the hawsers.

The towing pendant is shackled to its deck clench and belayed to the bollards with one turn round each bollard, and the other end is led aft and to it is shackled the towing slip. A towing shackle is provided in case the other ship does not send one over with her hawser. If cable is used for the inboard part of the tow-rope a half shackle of it is shackled to the slip ; a swivel may be shackled to its outboard end, and a messenger is shackled on to the third link from its outboard end with a joggle shackle. If cable is not used wood packing for the fairlead and rounding for serving the hawser should be provided. A Carpenter's stopper is shackled to the deck clench before the after fairlead, and shot mats are provided under the stopper and the towing slip.

If the tow is undertaken in fairly shallow water, and if it may have to be slipped in an emergency and recovered later at short notice, provision should be made to buoy the end of the towing hawser ; a fibre or wire hawser of suitable size and length bent to an oil drum should suffice for this purpose.

Establishing Contact

Contact with the ship to be towed may be established by means of a gun and gun-line, or by a boat towing the grass hawser.

If the ship to be towed is drifting fast she may stream a boat's sea anchor on a grass hawser so that it lies to windward of her and can be grappled by the other ship ; or the towing ship may tow a buoy on a grass hawser across the other ship's bows or stern for her to grapple.

Passing and Securing the Tow

As soon as the grass is in hand in the towing ship, the grass and then the manila are run in until the strain comes on the towing hawser, which is then paid out from the other ship and walked in with the manila.

In the towed ship the starboard bight of the towing hawser is paid out on its paying-out rope, a hand being detailed to lever the shackle over any obstructions on the deck with a handspike. When the end of the bight is eased through the fairlead the paying-out rope is unshackled from it, and the Carpenter's stopper is taken off the port bight of the hawser which is then paid out in the same way as the starboard bight.

When the stress on the manila gets too heavy for the hands in the towing ship to haul it in it is taken to her after capstan and hove in, and when the eye of the hawser has come in through the fairlead the hawser is hung on the Carpenter's stopper and the eye shackled either to the end of the half-shackle of cable or to the towing slip. If the half-shackle of cable is used its messenger is taken to the after capstan, the weight of the hawser is taken on it, the Carpenter's stopper is taken off the hawser, and the hawser and half-shackle of

cable are veered out through the fairlead by the messenger. A signal is then sent to the other ship that the tow has been secured.

The towed ship then veers the required length of port cable and secures it by setting her port cable holder at "brake to brake" and putting on the riding slip as a preventer. The length of cable veered depends upon the depth of water, the weather conditions, and the nature of the tow, but it can be said that the greater the length of cable veered the less likelihood will there be of the tow-rope parting provided that its bight is clear of the bottom.

Slipping the Tow

In the towing ship the manila is bent to the towing hawser with a rolling hitch below its eye and securely stopped to the eye, and it is then taken to the after capstan. When the towing hawser is slack and the order is given to slip the tow the weight of the bight of the towing hawser is taken on the manila by heaving in the capstan, and the towing slip is then knocked off. The towing hawser is then veered outboard by the manila from the towing ship while it is being hove in by hand or power in the towed ship. When about half of the towing hawser has been recovered in the towed ship there should be little weight on the manila, which can first be surged, then cast off the capstan, and then paid out with the grass bent to its end. The remainder of the hawser, the manila, and the grass, are then run in by the towed ship.

In the towed ship a wire rope messenger of suitable size is led from the bow fairlead as far aft along the forecastle as possible, where it is rove through a leading block and then taken forward to the capstan. Just before the tow is slipped it is shortened in by heaving in on the cable holder and recovering the length of cable paid out. When the eye of the towing hawser is hove inboard the Carpenter's stopper is put on the hawser and the messenger shackled to the eye. When the tow is slipped from the other ship the Carpenter's stopper is cast off and the towing hawser hove in on the messenger by the capstan until the eye reaches the leading block. The Carpenter's stopper is then put on the hawser and its eye securely stoppered; all hands then man the hawser, the Carpenter's stopper is cast off, and the hawser is first walked in and then run in with the manila and grass. If, however, the weight of the bight of the hawser is too heavy for the hands available another fleet must be hove in by the messenger.

It is impracticable to stow the hawser on its reel as it is hove in because this would take too long; it must therefore be ranged on deck in a similar manner to that in which it was ranged for paying out, and then be stowed later. Care should be taken to wash it with fresh water and to lubricate it as it is stowed on its reel.

TARGET WORK

Details of the various types of target provided in the Royal Navy are to be found in the *Handbook on Targets* (B.R. 1596) and in the *Instructions for H/S Target Service* (B.R. 1593). In this section only a general description of some of the surface types of towed targets, together with some notes on their rigging and their handling, are given.

Twin Float and Larne Targets

These are the smallest towed targets, and are generally known as " splash targets " because, when towed at speed, a plume of spray is thrown up above and about them ; the greater the speed the higher will be the spray. They are suitable for practices with all types of medium and close-range weapons in calm to moderate weather. Each can be towed at speeds of between 10 and 28 knots, using a tow-rope of 300 fathoms of $1\frac{1}{2}$ -inch F.S.W.R.

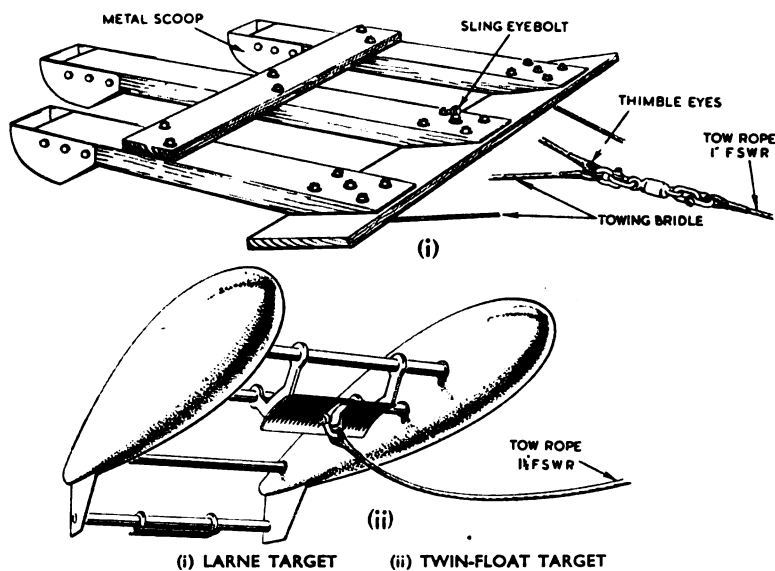


Fig. 257. Types of small high-speed targets

Pattern V or Hong Kong Target

This target consists of a wooden raft, $8\frac{1}{2}$ ft. long and 7 ft. wide, on which are stepped two masts, each $4\frac{1}{2}$ ft. long and stayed by two stays of $\frac{1}{2}$ -inch F.S.W.R. led to two eyebolts situated amidships on each side stringer of the raft. The masts are fitted with a wooden frame to which is nailed interlaced strips of black hessian to form a sail 6 ft. long and 4 ft. high ; the strips should be folded double to $3\frac{1}{2}$ in. in width and stitched at their sides. The raft is specially constructed to enable it to be shaken and stowed in a confined space on board a ship, and is readily reassembled when required. A two-legged towing bridle of $1\frac{1}{2}$ -inch F.S.W.R. is shackled to two eyebolts situated amidships and on the inner side of the side stringers ; each leg of the bridle is rove through a lizard lashed to the side stringer before the eyebolt. To hoist the target in and out it should be fitted with two slings of $1\frac{1}{4}$ -inch F.S.W.R., one on each side, and shackled to eyebolts at the end of each side stringer, so that when the target is slipped from a trip-hook the slings will fall on their respective sides and clear of the masts.

The target is suitable for sub-calibre or one-inch aiming-rifle practice from a ship at anchor or under way, and can be towed at speeds of up to 25 knots and in winds up to Force 5, Beaufort scale, using a $1\frac{1}{2}$ -inch F.S.W.R. tow-rope of 300 fathoms.

If two or more of these targets are towed astern of each other a larger tow rope may have to be used. As the weight of the bight of the larger rope would tend to submerge the leading target, its bridle should be attached to an Oropesa float and the end of the tow-rope be attached to the float.

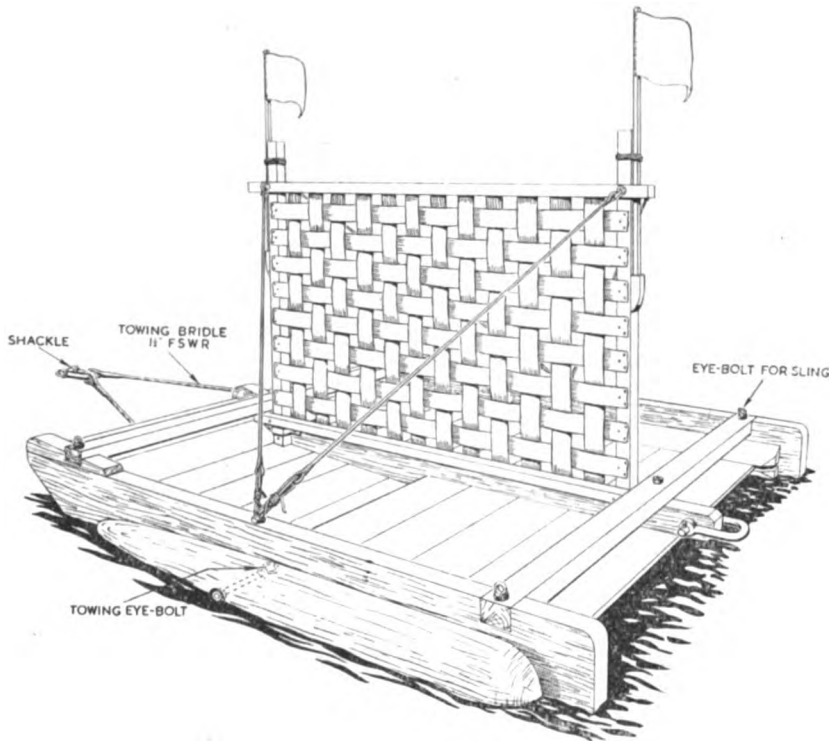


Fig. 258. Pattern V or Hong Kong target

Pattern VII Target (Fig. 259)

This consists of a wooden raft 16-ft. long and 10-ft. wide, very similar to the Hong Kong target and also constructed to be quickly shaken and readily reassembled on board a ship. It carries three 8-ft. 9-in. masts, to which is bent an 8-ft. by 10-ft. black hessian sail. The foremast and mizzenmast are stayed by a forestay and a backstay, respectively; a triatic stay, fitted with a cut splice which takes over the head of the mainmast, is fitted between the foremast head and the mizzenmast head, and each mast is stayed by two shrouds. The stays and shrouds are of one-inch F.S.W.R. and are set up by lanyards to eyebolts in the raft. The sail is secured at its four corners and centre to the head and foot of each mast by earrings, its head is laced to the triatic stay, and its luff and leach are laced to the foremast and mizzenmast respectively.

The towing bridle consists of two legs of 2-inch F.S.W.R., each 20-ft. long. The legs are shackled to eye-plates at the after ends of the side stringers and rove through the rings of two 2-inch F.S.W.R. stirrups secured to the forward ends of the side stringers, and their ends are spliced to a towing shackle (Patt. 5347). The ends of the legs and stirrups are fitted with thimble eyes, and the

splices should be tucked four times, twice with whole strands, and once each with half and quarter strands, the splices being parcelled with oiled hessian and served with tarred spunyarn. Slings similar to those of the Hong Kong Target should be fitted for hoisting the target in and out.

The target is suitable for sub-calibre or one-inch aiming-rifle practice from a ship at anchor or under way, and it can be towed at speeds up to 25 knots and in winds up to Force 5 Beaufort scale, using a 300 fathom tow-rope of $2\frac{1}{8}$ -inch target-towing wire rope.

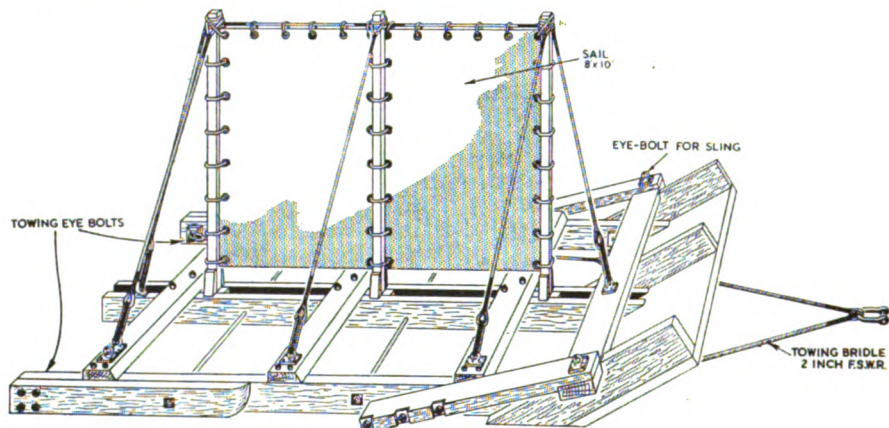


Fig. 259. Pattern VII target

Pattern II Target

This target consists of a wooden lattice-work structure, 30 feet long and 16 feet high, mounted on a wooden raft 30 feet long and 13 feet wide and stayed by three stays each side, each of one-inch F.S.W.R. Two canvas sails are provided, each 5 feet wide and 30 feet long, which are laced to the lattice-work

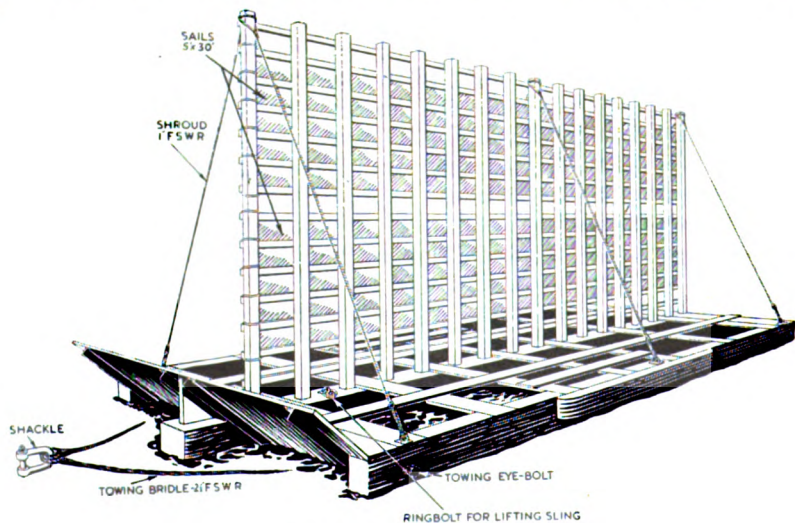


Fig. 260. Pattern II target

5 feet apart ; in strong winds the upper sail should be furled. The towing bridle consists of two legs of $2\frac{1}{2}$ -inch F.S.W.R. each 10 feet long, the ends being shackled to eye-bolts at the forward ends of the stringers. A similar bridle is fitted aft to enable two or more of these targets to be towed in tandem.

This target is suitable for full-calibre practices by guns of 4.7-inch calibre and below, and it can be towed at speeds up to 20 knots in calm weather, using a $2\frac{1}{2}$ -inch wire tow-rope. For sub-calibre firings the length of tow should be not less than 300 yards, and for full-calibre firings it should be 750 yards. These targets are of little use at ranges of over 14,000 yards.

High-Speed Battle-Practice Targets (Fig. 261)

These targets are supplied in two sizes of similar design, and consist of a wooden hull with a keel of steel plating carrying a wooden lattice-work structure, which, in the larger target is 145 feet long and 30 feet high, and in the smaller is 126 feet long and 30 feet high. Each target is provided with three canvas sails, each 10 feet deep and either 145 or 126 feet long, which are laced one above the other to the lattice-work ; in strong winds the upper sail should be furled. The lattice-work is stayed at intervals by shrouds, and near each of its ends is stepped a mast, each of which is fitted with a stayed topmast and two signal halyards. The deck of the hull is fitted with six pairs of bollards, three on each side, for use when towing the target alongside a vessel. Each target is fitted with three eye-plates for towing, two at the forward end and one at the after end of the keel, to which are shackled four 15-foot chain-towing pendants, two to the foremost eyeplate and one to each of the others. The pendants for a 145-foot target are of $1\frac{1}{2}$ -inch chain, and for a 126-foot target are of $1\frac{1}{2}$ -inch chain, and each is fitted with a recovery pendant to enable its end to be hauled aboard the target when the tow is slipped. Normally, the target is towed from the foremost eye-plate by one towing pendant, the other two being provided as spare pendants ; the aftermost pendant is provided for use when two of these targets are towed in tandem. A 50-fathom span of $3\frac{1}{2}$ -inch or 4-inch F.S.W.R. is shackled to the towing pendant and coiled down in the bows of the target ; to this span is shackled a swivel and the tow-rope. Coir fenders are fitted at the bows and stern, and along each quarter ; and a bull-ring is fitted in the eyes of the target through which a $2\frac{1}{2}$ -inch mooring bridle is rove when the target is moored to a buoy.

These targets are used for full-calibre practices for all guns from 4-inch upwards, and can be towed at speeds of up to 20 knots in calm weather with a $3\frac{1}{2}$ -inch or $4\frac{1}{2}$ -inch F.S.W. tow-rope. The length of tow depends upon the range at which the practice is carried out ; 750 yards is used for practices at ranges of up to 16,000 yards, and 1,000 yards for those at over 16,000 yards range and for all night practices.

Handling Battle-Practice Targets.—In confined waters such as those of a harbour or an anchorage the target should be towed astern at short stay, or alongside. When towed at short stay by a vessel such as a sloop or a destroyer the length of tow should be not less than 40 fathoms, otherwise the propeller-wash may cause the target to yaw.

When towed alongside it is recommended that the target should be towed stern first by two $2\frac{1}{2}$ -inch wire berthing hawsers, rove as springs from the quarter and midship bollards of the target, and that a 2-inch wire breast-rope be rove to its quarter bollards. The length of the springs should be adjusted

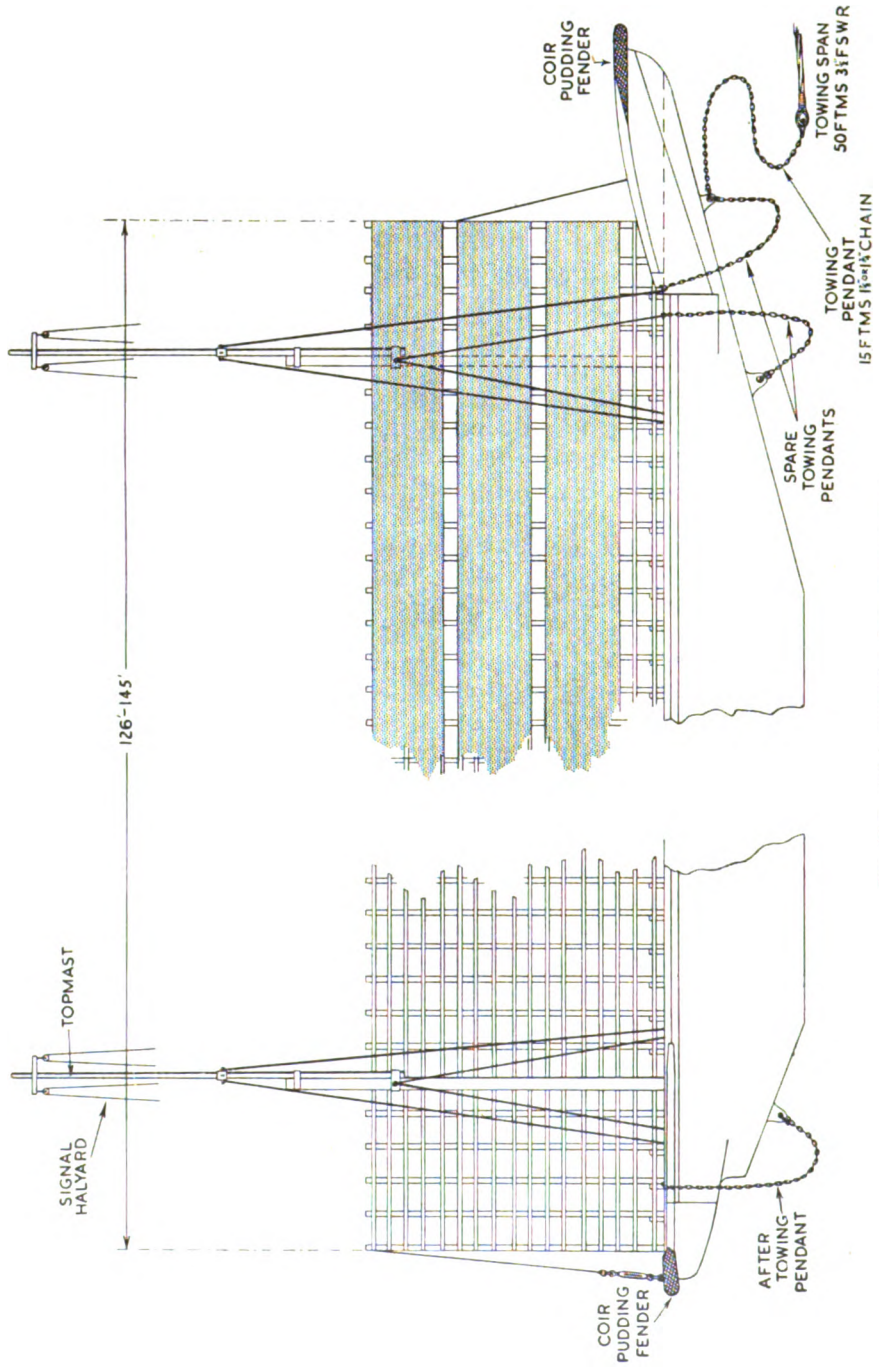


Fig. 261. High-speed battle-practice target

so that the target tows with its bows just ahead of the towing vessel's propeller ; the towing span should be stopped to the quarter guardrails of the towing vessel, led inboard through her after fairlead, taken to the towing bollards with a figure-of-eight turn, and then brought to the capstan with five turns. With the target secured in this manner it should tow comfortably at speeds of up to 10 knots in calm waters.

To veer the target astern from alongside to short stay the towing vessel lies stopped with the wind on the bow which is furthest from the target, and the springs and breast are cast off. The towing vessel then goes slowly ahead into the wind, at the same time cutting the stops of the towing pendant and veering it to short stay.

To veer the target from short stay to the required length of tow the towing span is shackled to the first 3½-inch or 4-inch towing hawser by a towing shackle, which is designed to work easily round bollards or a capstan. The tow is then veered astern while the towing vessel goes slowly ahead, usually at a speed of about 7 knots, which is sufficient to keep the bight of the tow-rope from fouling the bottom. Additional hawsers are shackled on and veered until the required length of tow has been veered ; speed is then reduced, the weight of the tow is taken on a Carpenter's stopper, the tow-rope is taken off the capstan, belayed to the towing bollards and well racked, and the Carpenter's stopper is cast off. The towing vessel then increases speed, in steps of 2 knots at a time, to that required for towing. To veer a target from short stay to 1,000 yards should take from 30 to 40 minutes, but to heave it in to short stay from this distance takes longer (from 45 minutes to one hour) because the hawsers have to be reeled up as they are recovered.

When towing at long stay the towing vessel should be manoeuvred so as to keep the bight of the tow-rope clear of the bottom, for which a minimum speed of eight knots will be required for a 1,000 yard tow and a depth of 30 fathoms. Alterations of course should be made in steps not exceeding four points at a time and with a small amount of wheel.

The nip of the tow-rope round the bollards should be freshened from time to time and at least once a watch. If it is impracticable for the target to carry side-lights the towing vessel should illuminate it at night by a searchlight or signal projector when encountering shipping on passage to and from the firing area.

To heave in the tow to short stay, speed is reduced to a minimum ; the weight of the tow is then taken on a Carpenter's stopper, and the tow-rope is taken off the towing bollards and brought to the capstan with five turns. The weight of the tow is taken by the capstan, the Carpenter's stopper is cast off, and the tow is hove in by the capstan, the hawsers being reeled up as they are recovered, until the target is riding at short stay on its towing span.

To bring the target alongside for entering harbour the towing vessel is manoeuvred to the required angle with the target and the wind so that, by going slowly astern, the towing span will spring the target alongside bow to stern, where it is then secured, as before by two springs and a breast rope. During this manoeuvre care must be taken to keep the bight of the towing span clear of the propellers of the towing vessel, if necessary under-running it with strops and stopping it to the quarter guardrails.

Kite Balloons

These small size balloons can be flown from Battle-practice, Pattern II, Pattern VI, and certain other high-speed targets, to give an indication of the position of the target by means of the radar reflector which they embody. They are flown at heights of from 100 to 600 feet (usually at 400 feet), the targets being fitted with a hand-operated balloon-winch mounted on a platform at their after end. They are only used when the relative speed of the wind does not exceed 40 knots.

Moored Targets

The size and nature of the mooring depends upon the type of target, the nature of the bottom, the tide and the depth of water. Under normal conditions a picket boat's or a launch's anchor should suffice for a Pattern II or a Pattern VII target, and a 5-cwt. or 7-cwt. kedge anchor for a Battle-practice target, backed if necessary with sinkers. The length of the mooring rope should be four times the depth of the water at high tide. Admiralty pattern anchors should not be used to moor a target for any length of time because, as the swings, the mooring rope is sure to foul the upper fluke of the anchor and so dislodge it. At about a fathom and a half from its upper end the mooring rope should be fitted with a two-fathom pendant, to which should be shackled an anchor buoy; this enables the target to be unmoored quickly without the necessity of having to weigh the mooring at the same time. If a target is to be left at a mooring overnight it should be provided with a riding light.

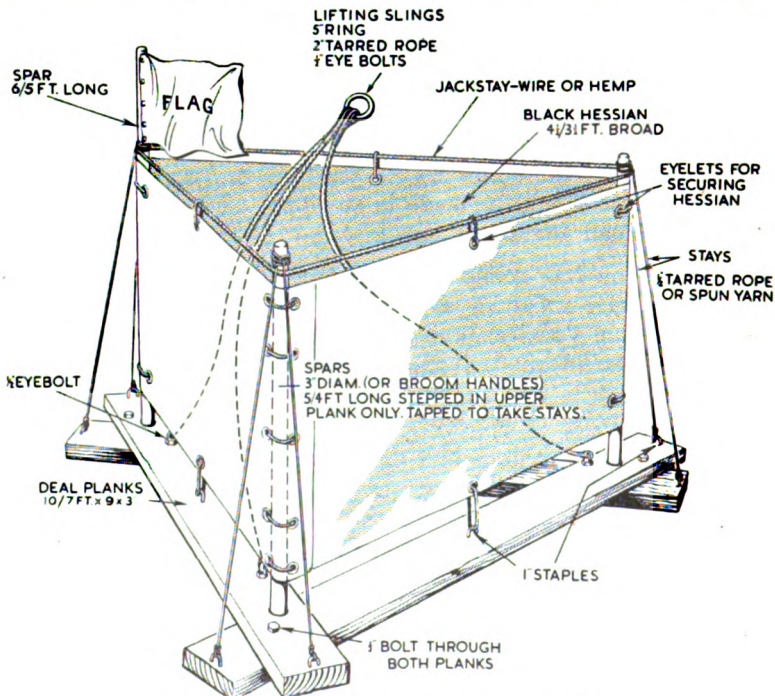


Fig. 262. A small triangular moored target

A small target which is suitable as a moored target and can easily be constructed on board is illustrated in Fig. 262.

CHAPTER XI

Paravanes and Minesweeping

PARAVANES

The Mine

A MOORED mine is a buoyant object containing explosives and moored to the sea-bed in such a manner that it keeps at the required depth beneath the surface of the water, this depth being determined by the height of low water at the place and the draught of shipping liable to pass over it. It can be of the "contact" type, which is exploded by contact with a ship's hull, or of the "influence" type, which is exploded by the magnetism of the ship's hull or by the sound of her propellers.

A mine which is directly in the path of a ship will probably not be struck by her stem, because the force of the bow-wave will swing the mine away from her bows; it will then swing back, pendulum fashion, and strike her hull at some point abaft her bows.

The Paravane

The paravane (or "P.V." as it is often called) is a kind of underwater kite designed to be towed from the fore-foot of a ship and to ride well away from her side at about the same depth as her keel. The mooring rope of a moored mine which lies in the path of the paravane tow-rope will be caught by this rope and slide along it towards the paravane, thus preventing the mine from swinging back towards the ship's hull (see Fig. 263).

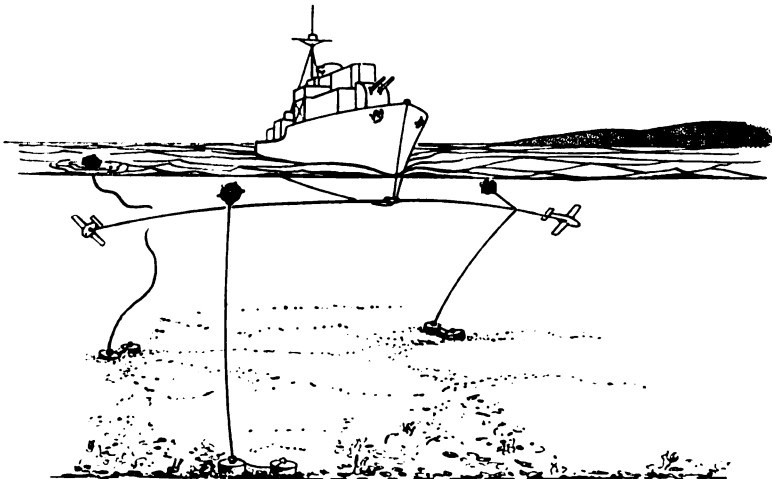


Fig. 263. Operation of the paravane

The paravane tow-rope is so constructed that it saws through the mooring rope of the mine, but if it fails to do this the mooring rope will eventually slide into special wire cutters, fitted between the towing point of the paravane and

the end of its tow-rope, and these should finish the cutting of the mooring rope. The mine will then float to the surface where it can be seen, and then be sunk or exploded by rifle or gun fire. It should be realised that a mine floating on the surface is not necessarily "safe", and every opportunity should be taken to sink or explode it. It should also be realised that paravanes only afford protection against moored contact mines, though they may cause a moored influence mine to explode further away from the ship's hull than it would do otherwise. Paravanes afford no protection whatever from ground mines, *i.e.* those which lie on the sea-bed.

Details of Equipment.—A paravane (see Fig. 264) is designed to be towed from one side of the ship only, but with a certain amount of adjustment a port paravane can be altered to tow on the starboard side, and *vice versa*. Each

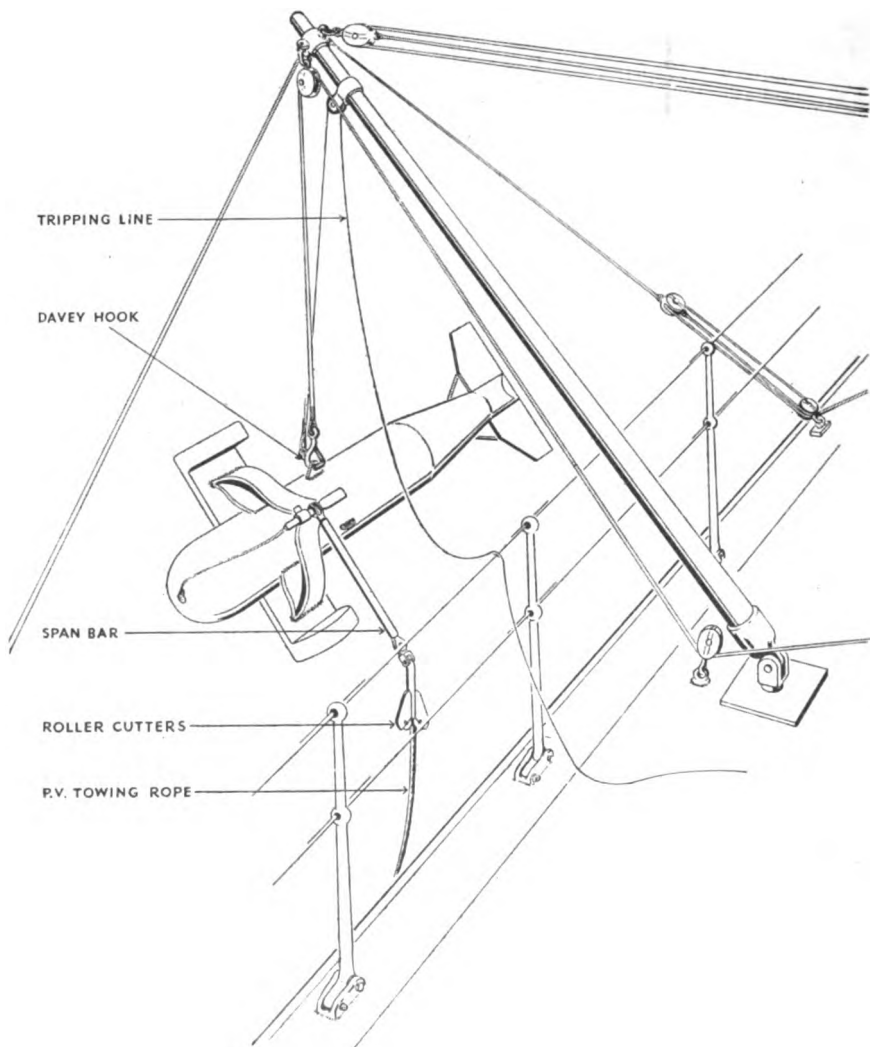


Fig. 264. A paravane slung ready for slipping

paravane has a serial number stamped on it, even numbers being used for port paravanes and odd numbers for starboard. A paravane can be fitted with various sizes of planes (wings) for various speeds of tow, and it is important to ensure that it carries the correct pair of planes for the speed at which it is to be towed; for this purpose, each pair has its designed range of speed stamped on it.

Between the paravane and its tow-rope is fitted a bar of steel, called a "span bar", which carries the special roller cutters for cutting the mooring rope of the mine. Span bars are designed for use on one side of the ship only, and are not interchangeable. The roller cutters are not fitted permanently on the span bars, and when not in use they should be kept clean and well greased and in the boxes supplied for them. The cutters are sharp and leather gloves should be worn when handling them.

The paravane tow-rope is made of special, three-stranded, 2½-inch galvanised steel wire rope, with a breaking stress of 19 tons. One end is fitted with a special connection for attaching it to the span bar, and the other is spliced with a thimble eye which is shackled to the towing shoe. The eye-splice is made with four whole tucks and one half-tuck, parcelled and served with spunyarn, never with wire. The length of the tow-rope depends on the type and class of ship; the exact length is to be found in the *Ship's Book*. The tow-ropes are laid up right-handed and left-handed; those of right-hand lay must always be used on the port side, and those of left-hand lay on the starboard side.

Typical Rig for Streaming and Recovering P.V.s

There are several different rigs for streaming and recovering paravanes, each suited to the type of vessel carrying them, but only one rig is described here in detail, this being the one which is fitted to many cruisers and some aircraft carriers (see Fig. 265). A brief description of other rigs is given on page 440.

Paravanes must be towed from the forefoot of the ship, the point of tow being as far down the stem as possible. The point of tow consists of a "V" shaped bar of steel, known as a "shoe", which travels up and down the stem and to which the tow-ropes of the paravanes are shackled.

The shoe is kept in place across the stem by two "backhauls" of wire rope tailed with chain, which run from the shoe to fairleads on each side of the forecastle just abaft the breakwater. The purpose of the chain tail is to take the chafe where the backhaul passes through the fairlead, and the end of each chain tail is connected by a Blake slip to large tackles with which each backhaul can be set up.

The shoe is raised and lowered on the stem by an uphaul and a downhaul, which consist of studded chain tailed with a wire rope messenger in the form of an endless whip. The shoe is slung on the uphaul, which leads inboard through a bull-ring on the stem head, aft along the forecastle, through a fixed leading block abaft the capstan, and thence to the capstan; the downhaul leads aft from the capstan, through a fixed leading block, then forward along the forecastle to a decklead just abaft the stem head, down through a pipe called the "chain-pipe", which runs down the length of the stem and just abaft it, and then out through a fairlead in the forefoot to the underside of the shoe. The length of the wire rope messenger is adjusted to allow of three and a half turns of it being taken around the barrel of the capstan when hauling the shoe up or down.

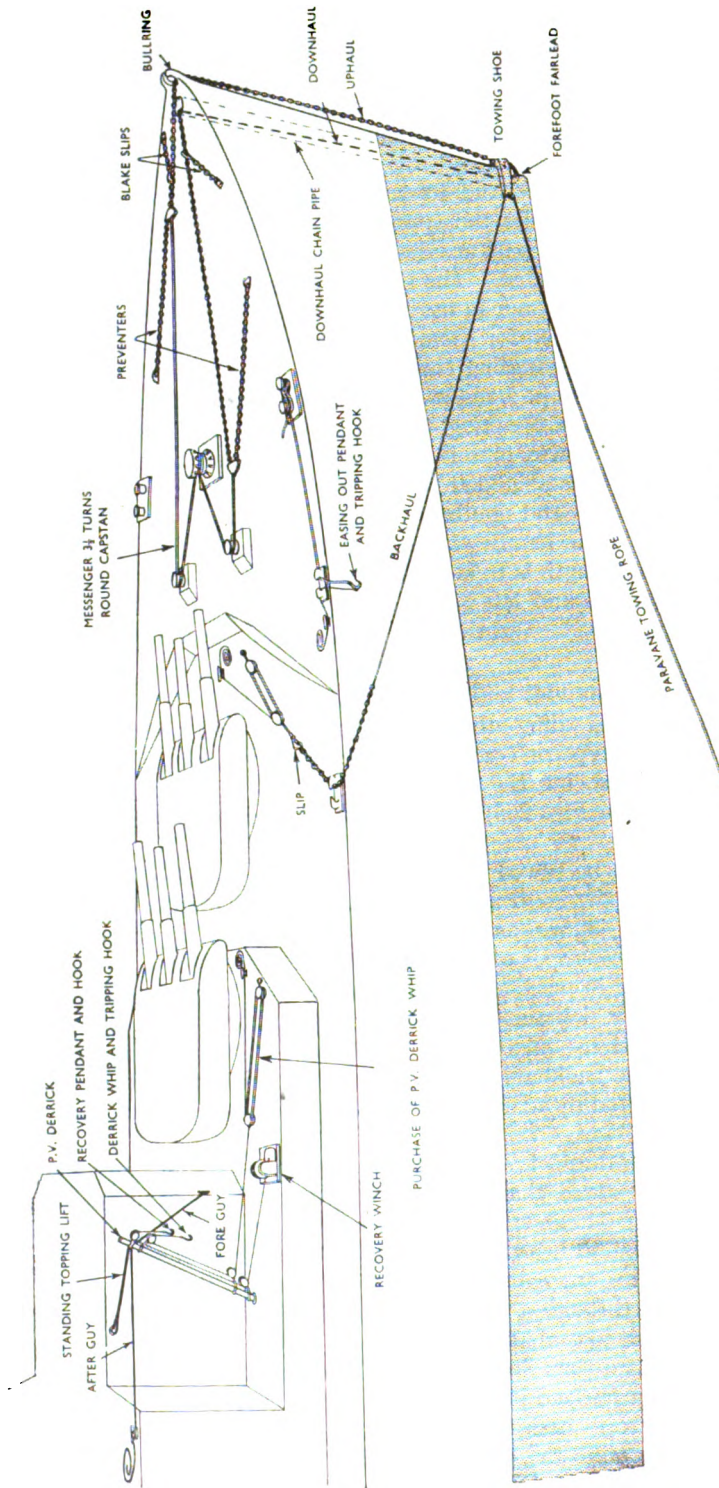


Fig. 265. Typical forecastle arrangements of a warship for working paravanes

Each end of the messenger is shackled to the ends of the uphaul and downhaul by a monkey-face, to the third eye of which is shackled a short length of chain, called a "preventer", whose other end is shackled to a deck plate. These preventer chains prevent the shoe from being hauled too far up or down the stem.

Two Blake slips are provided, one for the uphaul and one for the downhaul, to prevent any movement of the shoe in its up or down positions.

"Bench marks", consisting of brass plates let in to the deck, indicate the positions of the after ends of the uphaul and downhaul when the shoe is in its correct up or down position.

An "easing-out" pendant, to which is shackled a tripping hook with tripping line, is led outboard through a fairlead situated just before the breakwater, on each side. The pendant is hooked on to the paravane tow-rope and belayed with sufficient scope to hold its bight just outboard of the fairlead when the paravane is slipped. The pendant ensures that the paravane is towed initially at short stay, and when it is seen to be running correctly the pendant is surged until the hook is just below water, when it is tripped to allow the paravane to run out to the full scope of its tow-rope. Should the paravane "run wild" (*i.e.* erratically), however, the pendant will hold it at short stay and prevent it from fouling the bilge keel until it can be recovered.

A cordage hanger is provided at a suitable point on the gunwale, abaft the easing out hook, to keep the bight of the paravane tow-rope clear of the water until the paravane is slipped. The hanger should be passed so that when it is cut or slipped there is no chance of any part of it remaining on the tow-rope to foul the cutters.

A "recovery pendant", very similar to the easing-out pendant, is provided for recovering the paravane. It is fitted with a special hook with a broad palm, and its use is described later.

Streaming, Recovering and Running Paravanes

Preparation for Streaming.—The shoe is transported from its stowage and shipped over the stem; the uphaul and downhaul are correctly adjusted to their "up" positions, the messenger is brought to the capstan with three and a half turns round the barrel, and the ends of the uphaul and downhaul are shackled to the shoe; the backhauls are shackled to the shoe, rove through their fairleads, and set up with their tackles; the paravane tow-ropes are shackled to the shoe, led outboard of all, and shackled to the span bars which, in turn, are shackled to the paravanes; the bight of each tow-rope is kept clear of the water by the easing-out hook and the stopper; the P.V. derricks are rigged with wire rope pendants as whips, to the inboard ends of which are shackled deck tackles, and the paravanes are transported in their trolleys abreast the derricks and slung on the whips by Davey tripping hooks.

Streaming Paravanes (Fig. 266).—The speed of the ship is adjusted to the correct speed for dropping the paravanes in use. The backhauls are tended, and the shoe is lowered by the capstan to a position about three feet above the waterline. The derricks are swung outboard on their standing topping-lifts, the paravanes are lowered to within ten feet of the surface of the water, and the tripping lines are then belayed. When the paravane is slung ready for

slipping, its correct attitude in relation to the ship should be with its body horizontal or slightly tail down, its nose pointing slightly outboard, and its planes tilted at an angle of about 45 degrees (see Fig. 264).

On the order "Slip", both paravanes are lowered roundly on their whips, the Davey hooks trip, and the paravanes drop into the water and sheer out from the ship's side under water. When the slack in the bights of the tow-ropes is taken down, the cordage stoppers are cut or slipped and the paravanes tow at short stay on the hooks of the easing-out pendants.

When the paravanes are seen to be running correctly the easing-out pendants are surged until their tripping hooks are at the waterline; the tripping lines are then belayed, thus tripping the hooks, and the paravanes run out to the full scope of their tow-ropes. If both paravanes are running correctly, the backhauls are tended, the shoe lowered to its down position, and the Blake slips put on the uphaul and downhaul. The derricks are then rigged for recovery.

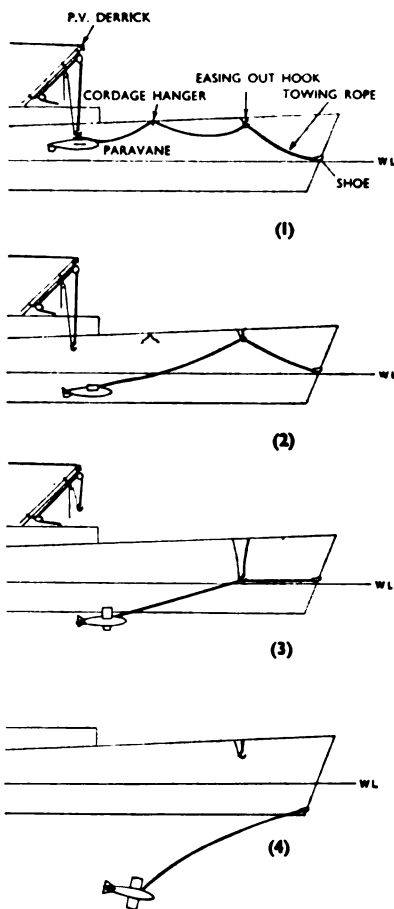


Fig. 266. Streaming paravanes
—sequence of operations

Recovering Paravanes (Fig. 267).—The Davey hook on the derrick whip is replaced by a spring hook with a socket (Patt. No. 8816), and the whip is stopped back on its running part. The recovery pendant is rove through an extra block provided at the derrick-head and brought to the winch, and both derricks are swung outboard. The recovery pendant with its hook is then taken outboard of all to the eyes of the ship, its bight being stopped as required to the guardrail to keep it clear of the water. The speed of the ship is adjusted to that required for recovery, the backhauls are tended, and the shoe is hove up to its "up" position. The ends of the recovery pendants are hooked on to the tow-ropes from the eyes of the ship, care being taken that the bills of the hooks face outboard. The bights of the recovery pendants are now tended, and the hooks are walked aft along the tow-ropes clear of the anchors and cat-heads, while all slack in the bights is taken down on the winches.

When the recovery pendants are taut and clear for running they are hove in at full speed on the winch; their hooks under-run the P.V. tow-ropes, thus tripping the paravanes and hauling them clear of the water. As the paravanes

break surface the speed of the winches is reduced, and the paravanes are fended off the ship's side by boathooks while they are hove up clear of the water to the derrick heads.

Staves are fitted to the sockets of the spring hooks on the derrick whips, which are then hooked on to the paravanes by means of the staves. The staves are then pulled clear of their sockets, the weight of the paravanes is transferred to the whips, and the paravanes are then hoisted by the deck purchases to the derrick heads, swung inboard, and stowed on their trollies. All gear is then replaced, or re-rigged for again streaming the paravanes.

Notes on Running Paravanes.—

A paravane is most likely to run foul just after it is slipped (probably through entering the water at an incorrect angle), or just after it is tripped (probably through being hove in at too slow a speed). A paravane is then liable to run towards the ship, and it may foul the bilge keel or other underwater projection from the hull, such as the pitometer log or the asdic dome if these are sufficiently far forward; if the paravanes are liable to foul either the pitometer or the asdic dome these should be housed when streaming or coverering paravanes.

If a paravane becomes lodged under the bilge keel it may be cleared by stopping the ship or getting stern way on her, or by shortening the scope of the tow-rope in the following manner :—

Heave up the shoe; snatch the bight of the tow-rope into a snatch block shackled to the end of the easing-out pendant, which is led from the eyes of the ship; take down all slack in the easing-out pendant, belay it in the eyes of the ship, and haul down the shoe. If there is not too much slack in the bight of the tow-rope this operation should haul the paravane forward and clear of the bilge keel.

If a mine becomes fouled on a paravane, both mine and paravane may be cast off by heaving up the shoe and cutting the tow-rope with special wire cutters.

Should it be necessary to jettison paravanes while streamed, the slips in the backhauls should be knocked off, the uphaul and downhaul be unshackled

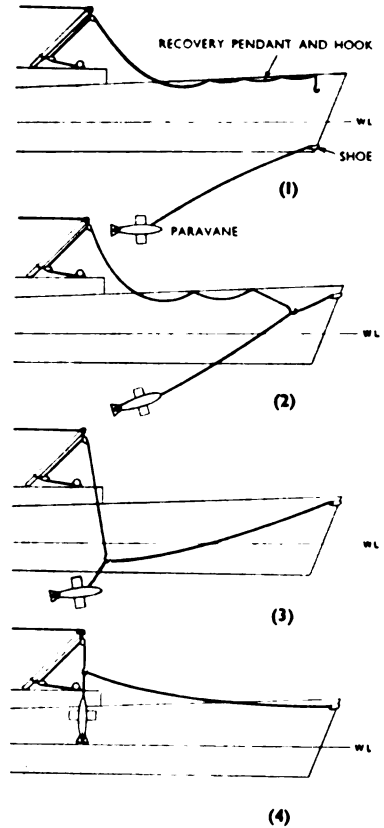


Fig. 267. Recovering paravanes
—sequence of operations

from their monkey-faces, and the uphaul and downhaul slips be knocked off. The shoe should then slide under the forefoot of the ship, and drop down and aft with its gear.

Paravane chains can be rove in the following manner when the ship is under way. With the ship stopped, a line with its bight suitably weighted is rove as a bottom-line under the stem and brought a little way aft; in ships with a raked stem the forefoot may be well abaft the catheads. A suitable and weighted line, such as a lead-line, is passed down the chain-pipe with sufficient scope to allow a fathom or two of it to hang below the forefoot. The bottom-line is now brought forward, and its bight is recovered with the end of the weighted line hanging over it; in ships with straight stems a little stern-way can assist this operation. The inboard end of the line can now be bent to the outboard end of the downhaul, and the latter be rove through the chain pipe and up to the stem-head.

Other Paravane Rigs

Some ships with raked bows may be fitted with a "planing shoe", for which the P.V. rig is simpler than that required for the bar shoe. The planing shoe consists of a plate shaped like a "V" to fit the stem of the ship, and on this plate is welded a lug the upper surface of which is inclined downwards at an angle of 17 degrees with the horizontal. The force of the water acting on the upper surface of this lug tends to force the shoe down the stem and, at the same time, holds it in place around the stem.

With this type of shoe a downhaul is not necessary because the weight of the shoe is sufficient to carry it down the stem to the waterline, and then the pressure of the water will force the shoe down to the forefoot. The shoe is slung on an uphaul, which is rove over fairleads at the stem-head and the inboard end of which is connected by a Blake slip to one eye of a monkey-face. To one of the other eyes of the monkey-face is shackled a wire messenger which is taken to the capstan, and to the remaining eye is shackled a preventer chain the other end of which is shackled to a deck plate. A Blake slip is provided in the eyes of the ship to hold the shoe in its "up" position. The shoe is raised and lowered from the capstan by means of the messenger and uphaul, and the preventer chain prevents the shoe from being lowered too far down the stem.

There is little likelihood of a planing shoe slipping off the stem, and back-hauls may therefore be dispensed with. In other respects the rig, and the methods of streaming and recovering paravanes, are similar to those for the bar shoe.

In ships whose bows are widely flared, such as aircraft carriers, it would be very difficult to hook the recovery pendant on to the P.V. towing rope when recovering paravanes. In such ships the paravanes are streamed with their recovery pendants attached to them, and these stream in a slack bight between the paravane and the ship while the paravanes are running. When recovering paravanes the recovery pendants are snatched into blocks at the derrick heads and taken to the winches. With this method, should the P.V. tow-rope part, there is a danger of the paravane being towed by its recovery pendant, in which case it might foul the propellers; each pendant is therefore tailed with a one-inch F.S.W. rope by which it is belayed when paravanes are running, so that if the tow-rope parts the tail will also part and allow the paravane to pass aft clear of the propellers.

MINESWEEPING

The object of minesweeping is to ensure the safe passage of friendly and neutral shipping by establishing "clear water" (*i.e.* water free from mines that may be dangerous to such shipping). Clear water in any particular area is established either by confirming the absence of mines in that area, or by clearing mines from it.

Types of Mine

Broadly speaking there are two types of mine, namely :—

- (i) "Contact" mines, which are exploded by contact with a ship, are invariably buoyant, and are moored by wire rope and sinker at various depths beneath the surface ;
- (ii) "Influence" (or non-contact) mines, which are actuated by one or more of the "influences" present near a ship (*e.g.* magnetic field, sound, or suction), and usually lie on the sea bed as "ground mines" ; some types, however, are buoyant, and are moored in the same way as contact mines.

Influence and Moored Minesweeping

There are two distinct types of minesweeping, "influence minesweeping" and "moored minesweeping". The details of all forms of minesweeping are given in the relevant handbooks on the subject, and all officers and some ratings undergo a course in influence minesweeping and in moored minesweeping before they are appointed or drafted to minesweepers.

Influence minesweeping is not dealt with in the *Manual of Seamanship*, because it is a complex and specialised operation involving special forms of sweep and requiring a high degree of technical training and knowledge.

Moored minesweeping is described in broad outline in the following pages because it is a less complex operation and is entirely concerned with applied seamanship. Broadly speaking, there are two types of wire sweep employed for sweeping moored mines, the "A" sweep, and the "Oropesa" or "O" sweep, both of which are described in the following paragraphs.

Types of Sweep

"A" SWEEP

This consists of a special serrated wire sweep rope, which is a very effective cutting agent and is towed through the water between two or more ships, its depth being regulated by "kites" (see Fig. 268) which are raised and lowered by each ship on a separate kite rope. The kite is attached to the sweep by means of a wire rope pendant and snatch block, and is so constructed that it tends to dive when towed through the water.

When only two ships are sweeping, the ship which provides the sweep is known as the "winch ship", and the ship which takes the end of the sweep is known as the "slip ship". When more than two ships are sweeping, all those in the formation except the wing ships are known as "centre ships".

All fleet minesweepers are fitted with a power-driven winch incorporating three drums. The two outer drums each carry 750 fathoms of sweep rope (left-hand lay on the port drum and right-hand lay on the starboard) and the

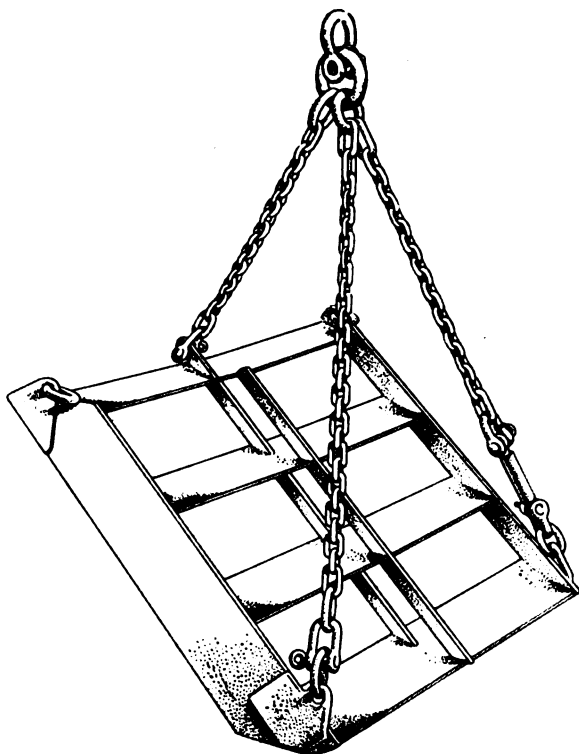


Fig. 268. Multiplane kite-otter

centre drum carries the kite rope, which is supplied in lengths of 100 fathoms and marked in paint from each end towards the centre at from 0 to 50 fathoms.

The kites are stowed aft on each side of the sweep deck, and are lifted out by means of a wire rope whip led through a special davit, similar to a torpedo davit and situated right aft each side of the sweep deck. The end of this whip is brought to a warping drum fitted to the winch and driven by the winch engine.

Passing the "A" Sweep between Two Ships (Fig. 269).—A black ball is hoisted at the masthead in both ships. The slip ship reduces speed to six knots and veers about 20 fathoms of grass line, with a barricoe or elliptical floats attached to its end, through the special roller fairlead right aft on the side on which the winch ship's sweep is to be received. The winch ship takes station three-quarters of a cable astern of the slip ship, and steers approximately for the wing of her bridge.

When ordered to "pass sweeps" the winch ship steers to grapple the floats or barricoe with a grapnel cast from her forecastle, and hauls the end of the grass line aboard her forecastle. Meanwhile, the sweep has been led out through the roller fairlead aft and along the winch ship's side, its bight being supported at intervals by chain stoppers fitted with cordage tails which are secured to the guardrails.

A special strop known as the "A" strop (see inset in Fig. 269) is shackled to the end of the sweep, and the strop is secured to the guardrail on the forecastle

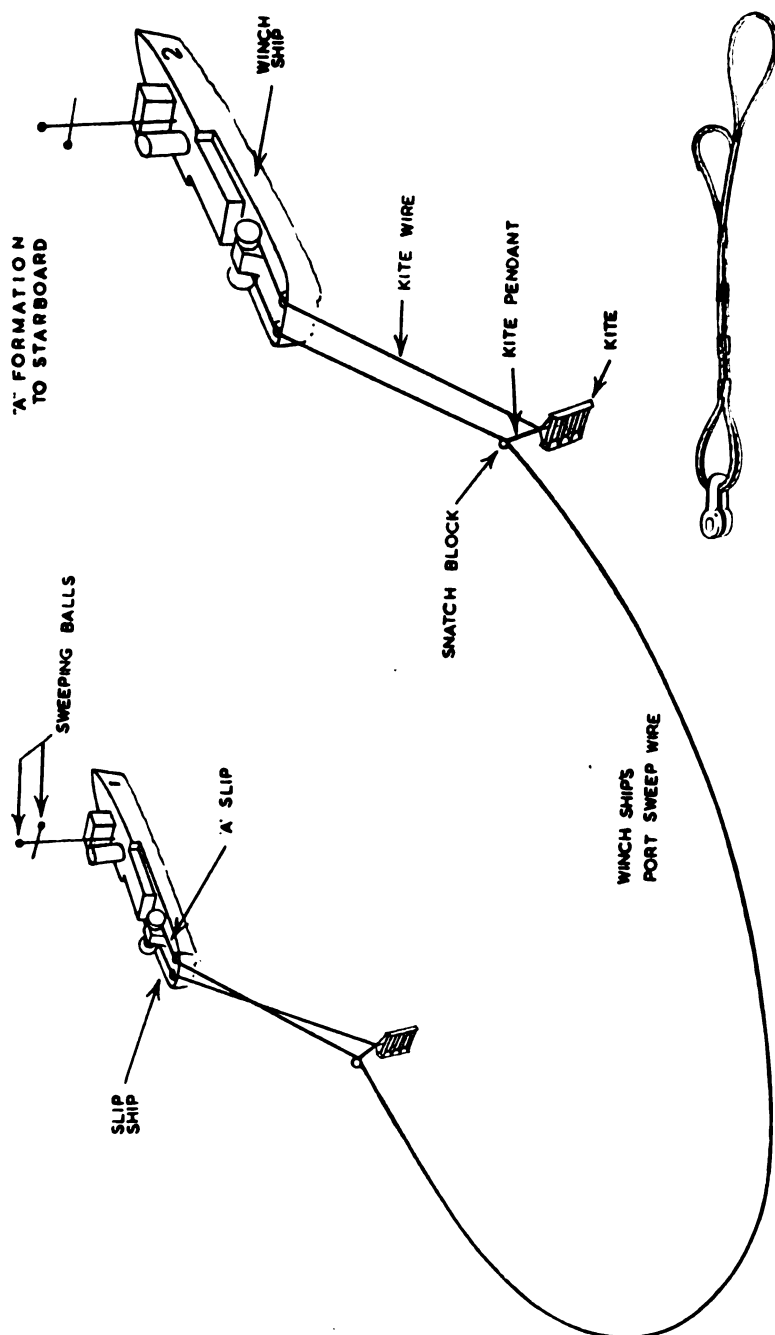


Fig. 269. "A" sweep—two ships. (Inset: "A" STROP)

**"J" FORMATION
TO STARBOARD**

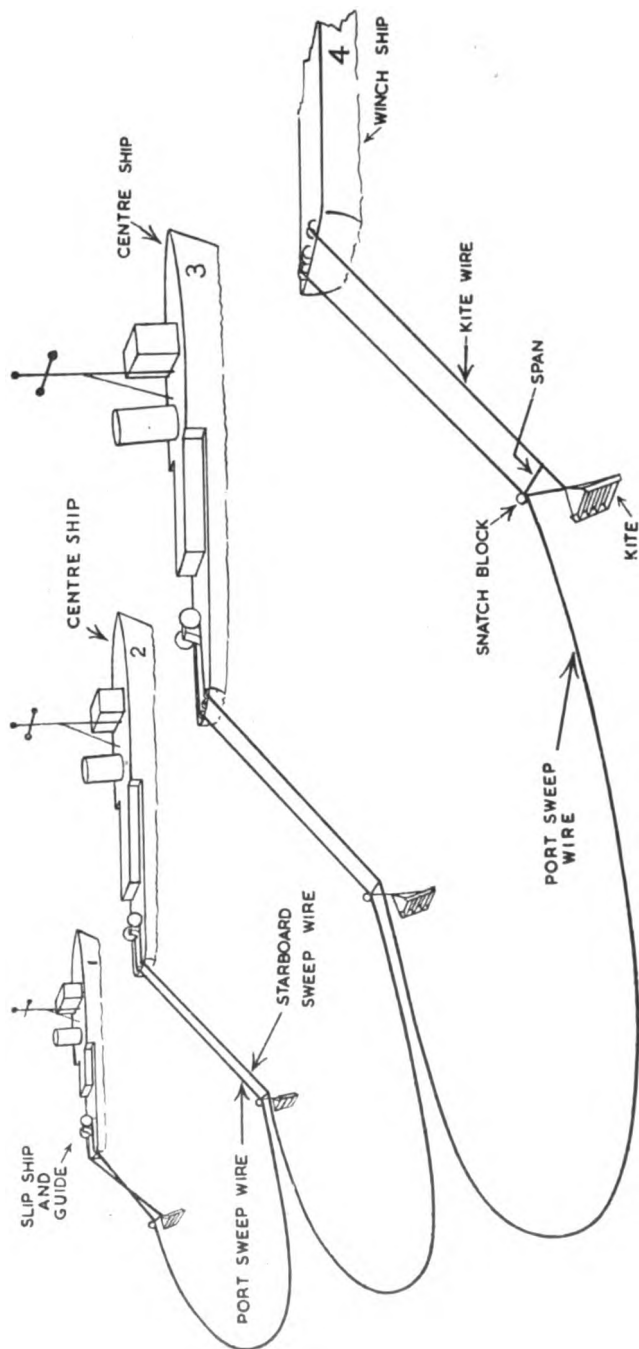


Fig. 270. "A" sweep—three to eight ships

of the winch ship. When the end of the grass line has been hauled inboard it is secured to the single eye of the "A" strop by means of Inglefield clips, and the grass line and floats are then thrown clear. Both ships hoist a black ball, at the dip, at the yardarm on the side on which the sweep is out; the officer on the forecastle of the winch ship holds up a large "H" flag as a signal to the sweep deck officer in the slip ship, and the grass line is then hove in by the slip ship, the chain stoppers being let go in succession in the winch ship as the strain comes on the sweep.

As soon as the slip ship starts to heave in the grass line the winch ship increases speed, hauls out to take station three-quarters of a cable on the beam of the slip ship, and at the same time veers approximately 120 fathoms of sweep from the winch. When the "A" strop is hove inboard in the slip ship the double eye of the strop is placed on a slip which is secured to the deck and known as the "A" slip. The grass line and floats are then unclipped and both ships hoist their yardarm sweeping balls close up.

The signal is then made to open out. The winch ship increases speed and alters course to take station $2\frac{1}{2}$ cables on the beam of the slip ship, veering the sweep at the same time. Kites are then snatched on to the sweep in each ship and veered to the depth ordered by signal.

Passing the "A" Sweep between Three to Eight Ships (Fig. 270).—With the most modern type of fleet minesweeper up to eight ships can sweep abreast with the "A" sweep, eight being the greatest number which can be manoeuvred together conveniently. With more than two ships the procedure for passing sweeps is slightly different. The two wing ships manoeuvre and operate their sweeps as described in the preceding paragraph, but the centre ships receive a sweep from their next astern and pass one to their next ahead. The sweep received by each centre ship is secured, not to the "A" slip on deck, but to a similar slip shackled to the end of one of their sweeps, so that the centre ships are using both their sweeps when sweeps are passed.

Kites in centre ships are slung between the "A" slip on the end of one sweep and the snatch block running along the other sweep. In addition, a wire rope span is used between the slip and the snatch block and the kite is thus hove in and veered by one of the sweeps, no separate kite rope being used.

Points to be observed when passing sweeps:

- (i) The chain stoppers must not be slipped too soon, or a large bight of sweep will form and put an undue strain on the grass line, which should be hove in with care to avoid parting.
- (ii) The slip ship should maintain a steady course and speed until the winch ship has opened out and is in station.
- (iii) The winch ship should veer her sweep on the brake of the winch when opening out. Kites should also be veered on the brake.
- (iv) Grapnels should be cast well over the grass line and ahead of the floats or barricoe, and then be allowed to sink before being hauled in.
- (v) Speed flags must be used in all ships throughout the operation. As well as the "H" flag already described, "V" flag (meaning "veer") may be used by the officers in charge of the sweeping gear in each ship to signal their requirements to each other.

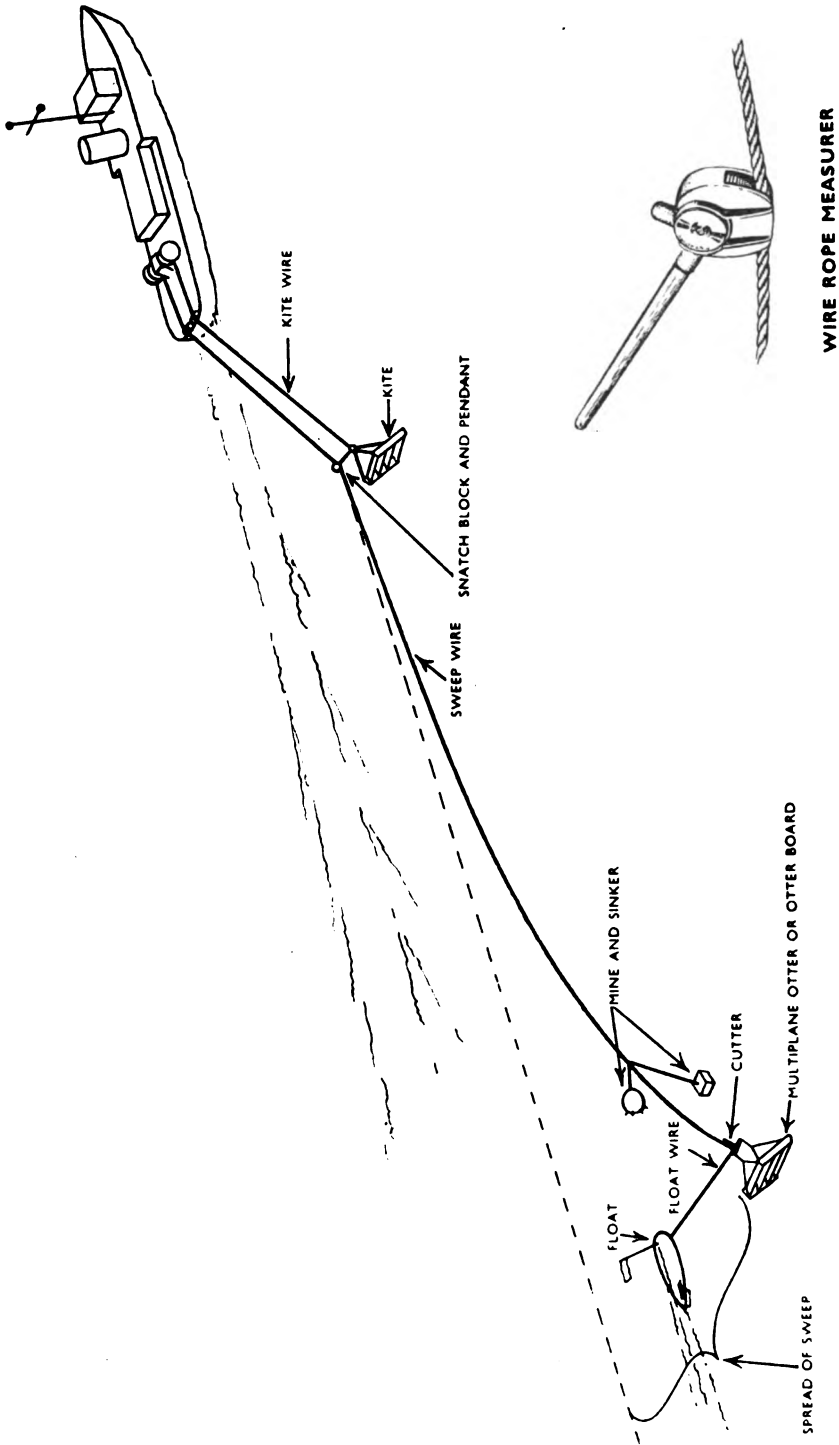


Fig. 271. The single Oropesa sweep. (inset : A WIRE ROPE MEASURER)

Parting of the "A" Sweep.—Parting of this sweep is usually caused through its fouling an obstruction on the bottom, or by a mine detonating in it. The ends of the parted sweep must be recovered by the two ships concerned, the section held by the slip ship being passed over to the winch ship if it is long enough or if there is sufficient time. The two ends are spliced together in the winch ship with a cut-splice.

Slipping the "A" Sweep.—To slip the sweep speed is reduced to six knots, and the winch ship closes to a distance of three-quarters of a cable from the slip ship, heaving in her sweep as she does so. Kites are raised before beginning to close in. When ordered to "sight and slip", the winch ship heaves in handsomely on her winch until the sweep breaks surface and is seen to be clear of mines or other objects. The slip is then knocked off in the slip ship and the end of the sweep hove in by the winch ship.

Should a mine be in the sweep, ships concerned must first attempt to cut the mooring by increasing and decreasing speed alternately, thus producing a sawing action in the sweep. If this fails, the mine must be towed into shallow water where it is certain to watch on the surface. Sweeps can then be slipped and the mine sunk by gunfire.

OROPESA OR "O" SWEEP (Fig. 271)

Unlike the "A" sweep which requires at least two ships to operate it, the "O" sweep is a single ship sweep. The sweep rope, which is serrated like that of the "A" sweep, is towed from the sweeping winch. The outboard end of the sweep is shackled to an otter, which is supported by a metal float joined to it by a float rope. The otter is in fact a kite, which lies on its side when towed owing to the substitution of four-legged slings joined to a towing beam for the three-legged chair slings of the ordinary kite. The otter tends to sheer out on the quarter when it is towed through the water. The float is fitted with a flagstaff and a flag to assist station-keeping; by night a light can be shipped in place of the flag for this purpose.

The depth of the sweep is regulated by means of a kite at its inner end, and the length of the float rope at its end. The kite is used and attached to the sweep in a similar manner to that for the "A" sweep, except that it always has a separate kite rope.

The otter used for the "O" sweep, and the kite used for both "A" and "O" sweeps, is, in fact, the same device, and is known technically as a "multiplane kite-otter". It consists of a series of curved metal vanes, fitted into a frame which is roughly square in shape (see Fig. 268). By fitting the appropriate chain slings the same multiplane can be used either as a kite, or as a port or starboard otter, as required.

Both legs of the "O" sweep can be towed at once. When this is done the kite is snatched to each sweep by a pendant and a snatch block.

Float ropes are supplied in various lengths so that the sweep can be towed at any depth required by shackling one or more float ropes together. The float is the only visual indication to the ship astern of the spread of the sweep.

Streaming the "O" Sweep.—The ship reduces speed to six knots, and the float is hoisted over the side on the minesweeping davit, to the whip of which it is secured by a Davy tripping hook. When the order "Out sweep" is given, the float is lowered and slipped and the float rope then paid out astern.

The otter, having been previously hoisted out and slung under the quarter, is slipped as the float rope grows taut, and the sweep is veered on the brake until 50 fathoms are out, when the brake is gradually applied. When the float is seen to sheer out on the quarter, indicating that the otter is running correctly, the sweep is veered to 300 fathoms, the speed of the ship being increased to eight knots to keep the bight of the sweep off the bottom. The kite is then snatched on and veered to the depth ordered by signal. The amount of sweep out is accurately measured by means of a special wire rope measurer supplied with the minesweeping outfit (see inset in Fig. 271).

Recovering the "O" Sweep.—Speed is reduced to eight knots, the kite is recovered and the sweep hove in. Speed can be further reduced to six knots when about 150 fathoms of the sweep have been recovered. When the otter is about to break surface the ship is stopped and the otter hove up close under the quarter. The float is then hauled forward by the float rope until the whip can be hooked by a spring hook on its end to the metal lifting bracket on the float. A boathook stave which fits into a socket on the recovery hook is used to facilitate hooking on the float; when hooked on the stave is pulled out and the float hoisted into its crutches. The ship can then go ahead.

Notes on the "O" Sweep.—When streaming both legs of the sweep the weather float and otter are streamed first and veered to 50 fathoms; then the lee float and otter are streamed, and when both floats and otters are seen to be running correctly both legs can be veered together to 300 fathoms. When recovering, both legs of the sweep are hove in together to 50 fathoms; the weather sweep drum is then disconnected and the lee sweep recovered first.

If a mine is seen to be in the sweep when recovering, the sweep must be veered to 50 fathoms, and the ship should then carry out large alterations of course and increases of speed to saw through the mooring.

Yardarm and masthead sweeping balls are used to indicate when the sweep is out, as follows:

- the masthead ball is hoisted when about to get out sweeps;
- the yardarm ball is hoisted at the dip when the float is slipped, and hoisted close up when the sweep is seen to be running correctly;
- the masthead ball is lowered to the dip when heaving in to recover sweeps, and hauled down when the floats are clear of the water.

COMPARISON OF THE "O" AND "A" SWEEPS

"A" Sweep, advantages:

- (i) There can be no "holidays" left between ships which are connected.
- (ii) The depth of the sweep can be altered with the sweep out.

Disadvantages:

- (i) When sweeping in shallow water, or close to the bottom, the sweep may foul the bottom and may part owing to the sag in its bight, which is much greater than in that of the "O" sweep.
- (ii) Mines may be dragged and remoored, instead of their moorings being cut, when used with low-powered minesweepers.
- (iii) If a sweep parts, a large holiday is left which must be swept again.
- (iv) Most, and in some formations all, of the minesweepers are in unswept water.

" O " Sweep, advantages :

- (i) By starting to clear a minefield from one side all sweepers can be kept in clear water.
- (ii) The sweep can be armed with cutters if obstructors or anti-sweeping devices are encountered.
- (iii) If the sweep parts, it is easier to fill the holiday.
- (iv) Station keeping, while just as important, is not so exacting as with the " A " sweep.
- (v) It is possible to use an " O " sweep for " skimming " (*i.e.* sweeping over the top of a deeply laid minefield to ensure that it is safe for surface vessels), as a nearly flat sweep can be obtained at high speed.

Disadvantages :

- (i) To carry out a sweep in which the minesweepers protect each other (*e.g.* " G " formation), a quarter-line formation must be used which makes visual signalling difficult.
- (ii) The swept channel is much narrower than that produced by an equivalent number of sweepers using the " A " sweep.
- (iii) The depth of the sweep cannot be altered during a lap without recovering the sweep and altering the float rope.
- (iv) The double Oropesa sweep is heavier to tow than the " A " sweep.

TWO-SPEED WIRE SWEEP

Destroyers can be fitted for this type of sweep, which is known as the " WT, Mark 1 ", but normally they do not carry it in peacetime. Full details of this sweep are given in the technical handbooks, and a brief description only is given below.

Principle of the WT, Mk. 1.—In broad principle the sweep is similar to the Oropesa sweep ; in the WT, Mk. 1, however, the sweeps are spread out on each quarter of the towing vessel by means of special paravanes which have their own depth-keeping mechanisms, and they are kept down at the ship end of the sweep by " tadpole depressors ". Small floats, which can carry lamps for night sweeps, are used in this sweep to indicate where the paravanes are running. (Fig. 272 shows a general view of the sweep.)

Uses of the WT, Mk. 1.—The sweep was named " two-speed " because it can be used at either high or low speeds. For *clearing* moored mines the sweep is used at speeds of up to 16 knots, and then has a big spread. At from 16 to 25 knots the spread of the sweep is reduced by the automatic changing of the angle of incidence of the paravane planes ; this is effected by special linkage gear which operates at about 16 knots. This reduction in spread is necessary to avoid over-straining and parting the sweeps. The high-speed (small-spread) sweep is used for *searching* for moored mines.

Gear Employed.—The sweep used is a special, neutral, serrated wire rope with a plain tail. Each paravane is fitted with a roller cutter similar to that fitted on bow protector paravanes ; in addition, a detached, static cutter is fitted in the sweep a few feet from the paravane. Arming cutters can be placed along the sweeps for dealing with obstructors or anti-sweeping devices in a minefield. The " depressor " has a tendency to dive dead astern (like the kite in Oropesa sweeping), and is towed on its own depressor rope (a P.V. rope) ; it pulls the sweeps down by means of the two spans and the snatch blocks connected to it,

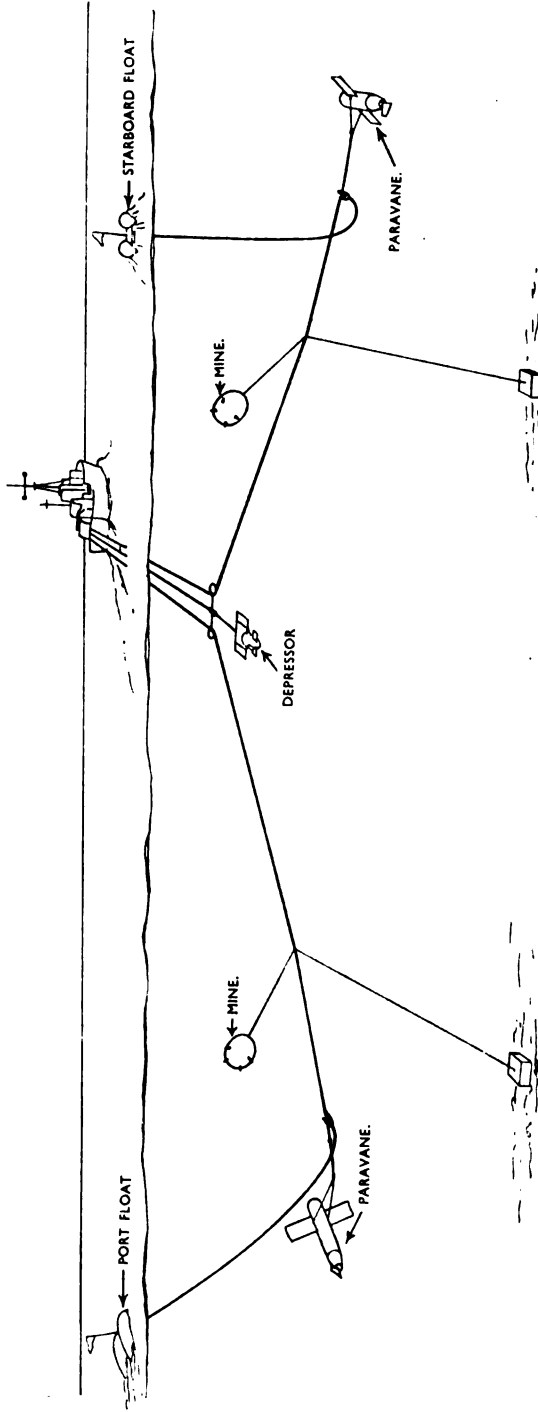


Fig. 272. Two-speed wire sweep (WT, Mark I)

Dan Buoys

Dan buoys are used in minesweeping to mark the limits of the area swept, but can also be used by any vessel for temporarily buoying any position.

Full details of the methods of laying and lifting Dan buoys, and how they are rigged, are given in the *Manual of Minesweeping*, but a short description of the buoy with its associated gear, and of one method of lifting and laying it, is given here.

The standard Dan buoy consists of a cylindrical can with a metal lifting bracket, and a tube through the centre of the can to take the Dan stave, which is clamped in position by two screw bolts, one at each end of the tube. The can is marked "top", but the top of the buoy is also easily identified as the lifting bracket is fitted on it. A drain plug is fitted to the top of the can. The Dan stave is fitted with two metal brackets, one at the top to take the electric lamp for night sweeping, and the other at the bottom for the half-hundredweight sinker. A boathook stave is lashed or clamped to the top of the Dan stave to carry the Dan flags so that the buoy can be seen at a distance. Size 4 flags are used, the best being those incorporating red and yellow or black and yellow, as these are the colours most easily seen from a distance. Special radar topmarks can also be used.

Dan Moorings.—These are supplied in lengths of 50, 20, 10, 5 and 2 fathoms, and are made of $1\frac{1}{4}$ -inch F.S.W.R. with a thimble eye in each end. The weight of the mooring is supported by a series of metal, elliptical floats, sometimes known as "fisherman's pellets" or "blobs", which are rove on to their own wire rope span and secured to the mooring rope with a running shackle and to the lug on the side of the can. Six floats are normally used, but more may be necessary in deep water or strong tides.

The Dan buoy is anchored to the bottom, either by a $1\frac{1}{2}$ -hundredweight sinker with a boat's anchor secured to it with two fathoms of $\frac{3}{8}$ -inch chain, or, if it is required to leave the buoy down for some time, by a five-hundredweight sinker backed up with a $1\frac{1}{2}$ -hundredweight sinker. A stray-line to assist in recovering the mooring is fitted to the upper end of the mooring rope and led to the top of the stave, where it is lashed with spunyarn.

Laying a Dan buoy.—Having assembled the buoy, as shown in Fig. 273, it is slung from a davit or derrick right aft, the whip or fall of which is hooked on to the metal lifting bracket with a trip hook. The mooring rope is flaked down clear for running, and the sinker and anchor are placed where they can be easily pushed over the stern. Shortly before reaching the position in which the buoy is to be dropped, the bight of the mooring rope is streamed, then the buoy is slipped, and, at the order "Let go", the sinker and anchor are pushed over the stern. The buoy will anchor itself in the position in which the sinker and anchor are let go.

Lifting a Dan buoy.—It should be decided whether the sinker is to be weighed forward by the windlass, with a whip rove through a block high up on the mast or superstructure, or aft by the winch, with a whip rove through a block on the minesweeping davit. In either case the ship approaches the buoy head on to wind and tide and first grapples the pellets by means of a grapnel cast from the forecastle. When the buoy is hauled in close under the bows it can be hooked on to the whip if lifting it forward, or taken aft along the ship's side to the davit for the recovery hook to be hooked on to the metal lifting bracket on the can. After the buoy has been recovered the pellets are unshackled and the end

of the mooring rope brought to the windlass or winch by means of the whip, which is secured to the running shackle on the mooring rope. The sinker and anchor are then weighed. The ship's engines should be stopped when the buoy is grappled and hauled in under the bows, but they can be put to "slow ahead" while weighing the mooring if it is being weighed from aft.

CHAPTER XII

Replenishment at Sea

THE term "replenishment" means the restocking of a ship with men, munitions, stores, provisions, fuel or water, and particularly the transfer of men and such commodities from one ship to another when both are under way at sea.

METHODS OF REPLENISHMENT

To effect these transfers the supplying ship and the receiving ship steam close aboard each other, either abreast or bow to quarter, or with the receiving ship astern of the supplying ship. During the transfer it is usual for the supplying ship to maintain a steady course and speed and for the receiving ship to keep station on her, but sometimes this procedure is reversed.

A transfer with the ships abreast each other or bow to quarter is called an "abeam transfer", and a transfer from one ship to another astern of her is called an "astern transfer". The transfers of men, munitions, stores and provisions are carried out by the abeam method, and those of liquids by either the abeam or astern methods.

Transfer of Solids

Solids are transferred by the "jackstay method" in which the loads are slung from a block, called the "traveller", which is hauled along a jackstay rigged between the two ships. Three rigs are provided, one a "light rig" and the other two "heavy rigs"; the light rig is designed for the transfer of loads of up to 500 pounds in weight, and the heavy rigs for loads of up to one ton and 2 tons respectively.

With the light rig the best working distance apart of the ships is 100 feet, and the maximum distance is 200 feet; with the heavy rigs these distances are 120 feet and 400 feet respectively.

Transfer of Liquids

Liquids are transferred with the ships steaming either abreast each other or with one astern of the other, the liquid being pumped through hoses rigged as described below.

- (i) *For abeam transfers* the hose is secured in troughs which are slung out-board, either from the supplying ship's derrick or crane, or from travellers running on a jackstay rigged between the two ships. The former method is known as the "derrick fuelling rig" or the "crane fuelling rig", and the latter as the "jackstay fuelling rig".
- (ii) *For astern transfers* the supplying ship streams the hose, which is buoyant, astern of her; the receiving ship then closes the end of the hose, grapples it and hauls its end in over her bows, and then connects it to her fuelling system. This method is known as the "astern fuelling rig".

The best and the maximum distances apart of the ships in these methods of transfer are :—

- with the crane rig, 95 and 110 feet ;
- with the derrick rig, 130 and 170 feet ;
- with the jackstay rig, 200 and 250 feet ;
- with the astern rig, $\frac{1}{2}$ cable and one cable.

General Requirements

STATION-KEEPING DURING TRANSFER

A steady course and speed by the supplying ship and correct station-keeping by the receiving ship are most important. For abeam transfers the distance between the two ships is measured by a "distance line", which is passed between the ships and kept taut at a position well forward where it is in clear view from the bridge of the ship keeping station. The line of $1\frac{1}{2}$ -in. manila may be 240 or 340 ft. in length ; it is marked at the zero position (30 ft. from the end) with a piece of leather and at subsequent intervals with bunting, as shown in Fig. 274a. Its standing end is hitched at the zero mark to the guardrails of the ship on which station is being kept, and the other end is tended in the ship keeping station so that it is always kept taut and at right angles to the fore-and-aft line, the latter ship being then conned to keep to the required mark. This line is usually the first to be passed and the last to be recovered, but for transfers of short duration it is not generally used.

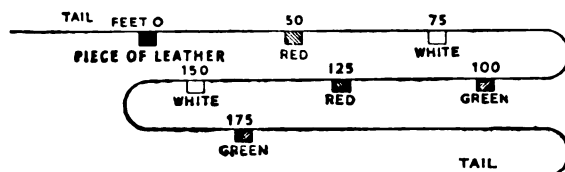


Fig. 274A. The distance line

COMMUNICATIONS

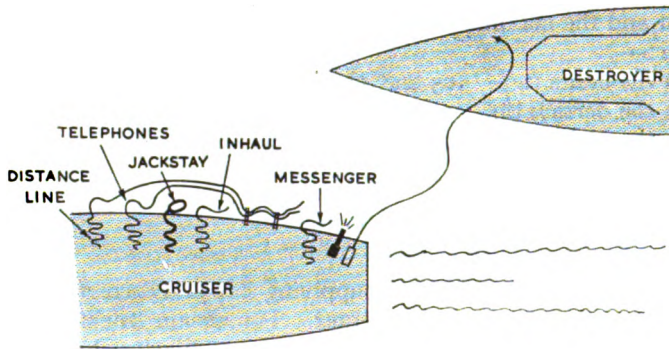
For all methods of transfer, communication between the two ships may be by telephone, voice wireless, loud-hailer, megaphone, or hand flags, but normally the telephone is used except for transfers of short duration. The telephone cables are usually provided by the supplying ship, and provision is made for direct communication between the bridges of the two ships and between each dump or fuelling position.

For abeam transfers the telephone cables are usually paid across immediately after the distance line. For astern transfers telephone communication is not usually provided.

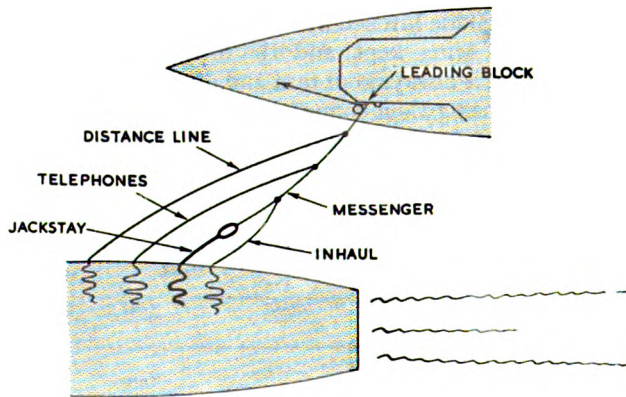
MARKING OF TRANSFER POSITIONS

For abeam transfers the transfer positions in each ship are marked by hand flags to assist in the initial stages of passing the transfer gear, the flags being displayed where they can best be seen from the other ship. The flags used are :—

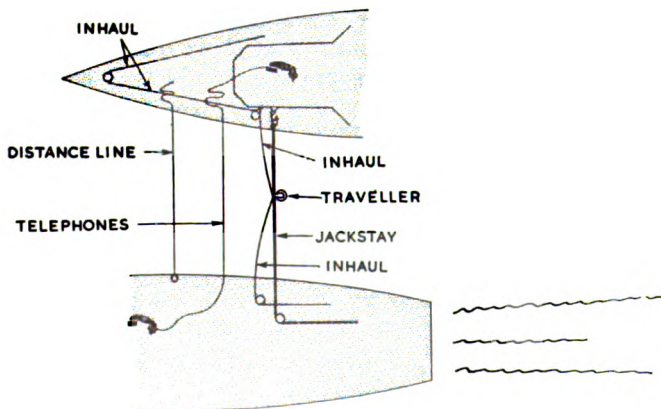
- red flag for oil fuel positions ;
- green flag for jackstay storing positions ;
- yellow flag for aviation fuel or petrol positions ;
- blue flag for lubricating or diesel oil positions ;
- white flag for water positions.



(i) ESTABLISHING CONTACT BY GUN-LINE



(ii) PASSING THE GEAR



(iii) JACKSTAY SECURED AND SET UP

Fig. 274B. Bow to quarter transfer by light jackstay—establishing contact and passing the gear

ESTABLISHING CONTACT FOR ABEAM TRANSFERS

When each ship has equal facilities, it is usual for the supplying ship to provide all lines and gear required for the transfer, but for transfers between small ships (such as destroyers) and larger ships (such as battleships and cruisers) the lines and gear are always provided by the larger ship. Contact between the ships is established with a special light line called the "gun-line", which is projected by a line-throwing gun called the "line-gun". The gun-line is usually provided by the ship which provides the transfer gear, and is aimed so that its end falls over, or in the vicinity of, the transfer position of the other ship. If the gun-line is of strong stuff the transfer gear (*e.g.* distance line, telephone cables, jackstay, or hose line) is bent to it and hauled across by it to the other ship. If the gun-line is not strong enough to bear the weight of the gear a messenger of about 40 fathoms of 2-inch cordage is bent to the gun-line and then hauled across, and, when the messenger is in hand in the other ship, the gear is hitched to it and hauled across.

If more than one form of transfer is to be carried out and the respective transfer positions in the receiving ship are far apart, two gun-lines may be projected; but, when practicable, only one gun-line is used to pass across all the gear required for the various rigs. Each item of gear is hitched to the gun-line or messenger at intervals of about a fathom, in the sequence: distance line, telephone cables (bridge telephone leading), and hose line or jackstay.

In Fig. 274b is shown the sequence of establishing contact and passing the gear for a simple bow to quarter jackstay transfer between a cruiser and a destroyer.

Before hauling the gear across, the gun-line or messenger should be snatched into a leading block; it should not be handed in over the guardrails.

If a jackstay is to be passed, the leading block should be directly above the jackstay slip so that the strop on the end of the jackstay can be put on the slip with the minimum of effort. If a hose line is to be passed, the leading block should be directly above the hose line leading block. (Details of the different rigs are given hereafter).

When passing gear from one ship to another the bights of the lines should not be allowed to trail in the water, as the resultant drag might haul the gear out of hand or part the messenger.

PROVISION FOR EMERGENCY

In all forms of replenishment, provision should be made to slip or cut away in an emergency the gear connecting the two ships. One hand should at all times be detailed for slipping the gear, and axes, mauls, and wire cutters should be provided at the transfer stations.

CASTING-OFF AFTER ABEAM TRANSFER

The gear should be passed back in the reverse sequence to that in which it was hauled aboard, care being taken to keep the different lines separated. The last length of line should be paid out to its extreme end and not be stopped in a coil and cast overboard, because the drag of the coil might well cause the line to part.

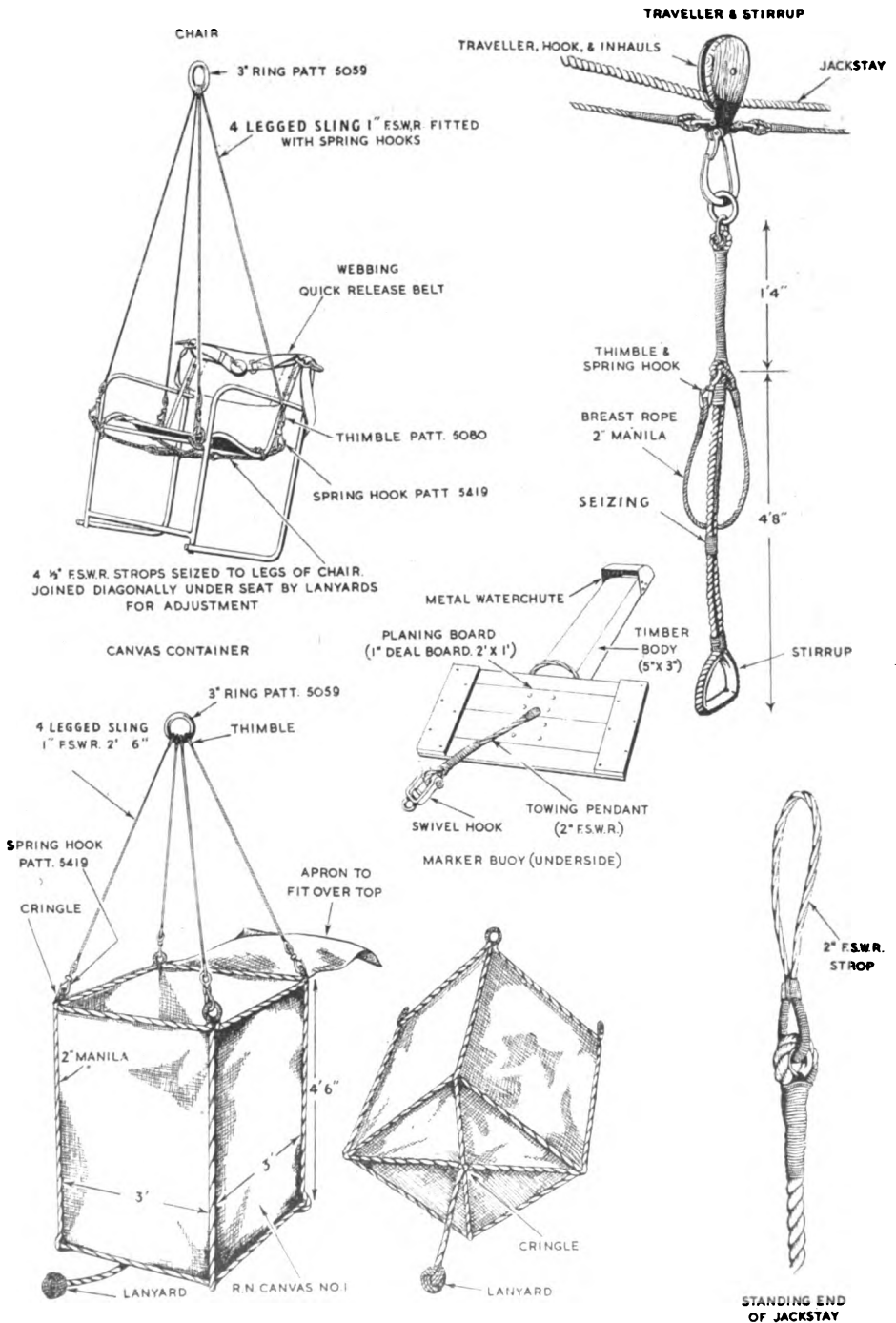


Fig. 275. Light jackstay transfer gear

TRANSFER OF SOLIDS

Light Jackstay Rig

A typical rig for transferring men and light stores by jackstay is shown in Fig. 276. The hauling end of the jackstay is manned by at least 20 men in the ship supplying the gear, and the other end is secured by its strop to a rigging slip in the other ship. The traveller is hauled back and forth along the jackstay by an inhaul in each ship, manned by two or more men.

Small miscellaneous stores are best transferred in a canvas container, details of which are shown in Fig. 275. Other stores may be slung from the traveller, or transferred in provision nets. Men are usually transferred by a stirrup, but a chair, rigged as shown in Fig. 275, may also be used; whenever a man is transferred he should wear a life-jacket. The traveller, with its hook, is a naval store article, but if one is not available an 8-inch clump block, or a 12-inch single block fitted with a spring moused swivel hook, may be used instead; if slings or provision nets are used the hook should be wide enough in the clear to take the bights of the slings or the beackets of the nets.

STRENGTH OF THE RIG

When setting up any rig of the jackstay type it should be borne in mind that the stresses imposed on certain parts of it depend on how taut the jackstay is kept, and that they may greatly exceed the weight of the load being transferred. The tauter the jackstay the greater will be the tension in it due to the load slung from it; and conversely, the slacker the jackstay the less this tension will be. When the angle made in the bight of the jackstay is 120 degrees the tension in it will be equal to the weight of the load slung, but if the jackstay becomes bar taut the tension will rise to infinity.

The tauter the jackstay, however, the easier it is to haul the traveller back and forth. In practice, the degree of tautness in the jackstay is dependent upon the pull exerted by the men manning it, which will seldom exceed the safe working load of the rope; but the stress on the leading blocks and their shackles and eyeplates will be much greater than any tension in the jackstay, and at these points it is prudent to allow for stresses of ten times the weight of the load to be transferred.

Applying this rule to the rig illustrated in Fig. 276, the maximum load which can be transferred by this rig is 500 lb., and then only if the gear is in first class condition.

SELECTION OF POSITIONS FOR THE RIG

If the ship is not fitted for jackstay transfer the following should be borne in mind when selecting positions for setting up the rig:—

- (i) the jackstay should be led at a height of at least 15 feet above the upper deck to enable the load slung from the traveller to clear the guard-rails, and it should be led to a point at least 12 feet inboard to allow the traveller to plumb the dump;
- (ii) the area of the dump should be large enough to accommodate an accumulation of stores and their handling party of six men, about 12 feet by 12 feet if available;
- (iii) there should be clear runs of at least 60 feet for the men manning the jackstay and for those manning the inhauls;
- (iv) there should be a clear run for the supply or removal of stores to and from the dump;

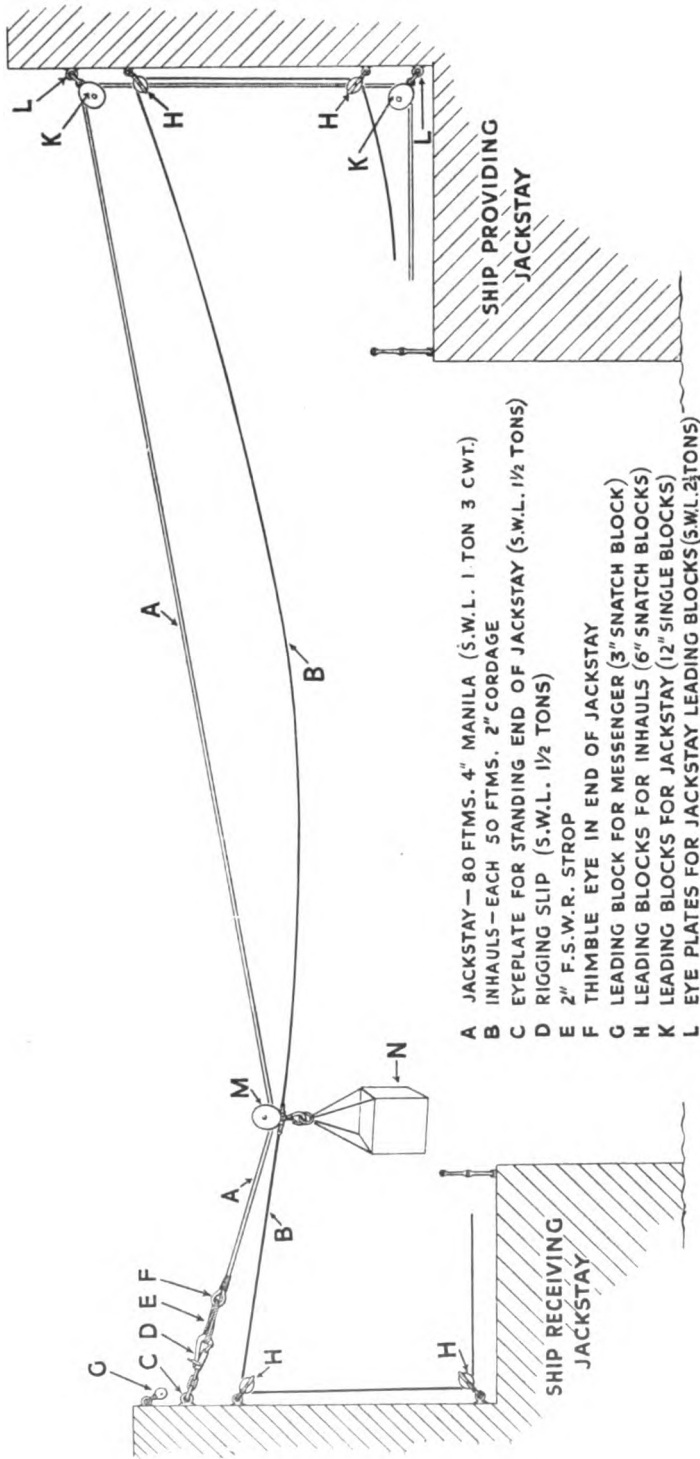


Fig. 276. The light jackstay rig

- (v) the rig should be as simple as possible, and as few leading blocks as possible should be used for the jackstay and inhaul because each causes loss of hauling power due to friction.

PASSING AND RIGGING THE GEAR

(a) *By the Ship supplying the Gear.*—The distance line, bridge telephone cable and dump telephone cable (if used), and the inhaul and jackstay (each tended by one or two men), are led outboard in that order from forward aft at intervals of about 10 feet. The distance line and telephone cables are led aft to the position from which the gun-line is to be projected. As soon as the gun-line is passed (assuming it to be a light line) it is bent to the messenger, which is then hauled across. When the messenger is in hand on board the other ship the lines are bent to it in their correct order, about one fathom apart, and paid out handsomely as the messenger is hauled in on board the other ship. When the jackstay is secured to its slip on board the other ship the slack is taken down and the first load is slung on the traveller ready to be hauled across.

(b) *By the Ship Receiving the Gear.*—The messenger is hauled over by the gun-line and snatched into a leading block secured just above the jackstay slip, and then the remainder of the lines are hauled across by the messenger; each line is unhitched as soon as it comes to hand and taken forward clear of the wake of the jackstay. The inhaul is snatched into its leading blocks and manned, and the strop of the jackstay is secured to the slip. The messenger is then flaked down ready for passing back the gear, and the gun-line is coiled up. One hand should be detailed to slip the jackstay in an emergency.

WORKING THE RIG

The time taken to complete a transfer depends chiefly on the time taken in hooking on each load, hauling it across, and then unhooking it.

Before a load is hooked on, the jackstay should be walked back to provide enough slack for the traveller to be handled on deck. As soon as the load is hooked on, the jackstay should be hauled taut, thus lifting the load clear of the dump. The order is then given in the other ship to run away with the inhaul and the load is hauled across. As soon as the load is fleeted home in the other ship the jackstay should be walked back smartly to lower the load on to the dump, where it is unhooked and hauled clear.

On no account should the bight of the jackstay be allowed to trail in the sea. In rough weather, obstructions in the vicinity of the dump should be well protected with fenders to prevent damage to the loads as they are hauled aboard. Two hands should be detailed for handling the traveller and hooking on and unhooking the loads. Between loads the traveller should be clipped to the top guardrail. If the guardrails are slipped and down, all hands working at the dump should wear life-jackets.

RETURNING THE GEAR

The messenger is rove through its block and its end is bent to the eye of the jackstay; the weight of the jackstay is then taken on the messenger and the jackstay is slipped. The inhaul is unsnatched from its leading blocks and its end hitched to the strop of the jackstay, to which is also hitched the coiled gun-line. The telephone cables and distance line are hitched to the messenger, about a fathom apart, and the jackstay is paid back to the other ship on the

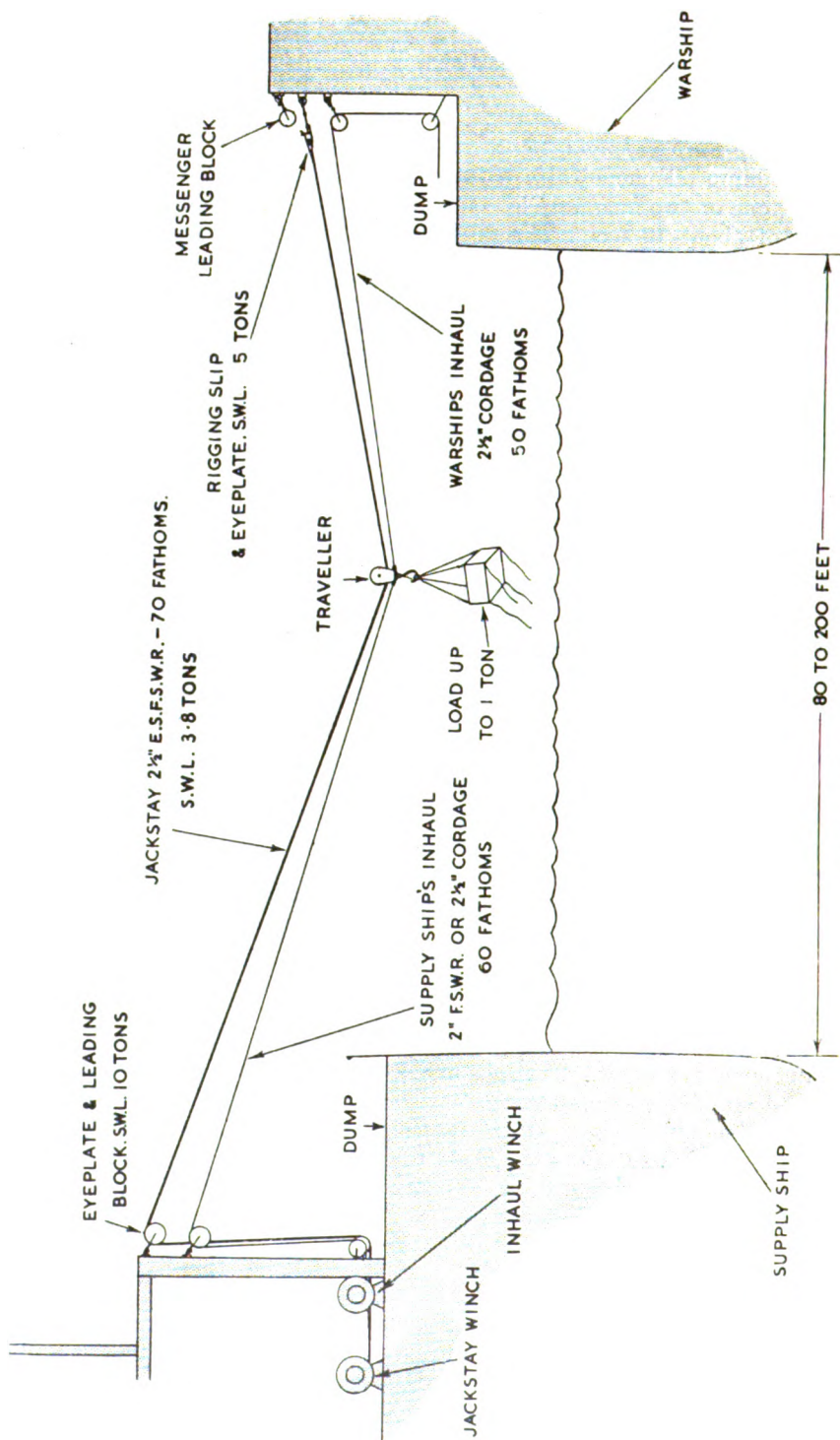


Fig. 277. The heavy jackstay rig

messenger. When all lines have been recovered in the other ship the messenger is unrove and the end cast overboard.

Heavy Jackstay Rig

A typical heavy jackstay rig, with which loads of up to one ton can be transferred, is shown in Fig. 277. In principle it is very similar to the light jackstay rig. The jackstay and the supplying ship's inhaul are worked by winches in the supplying ship, and the receiving ship's inhaul is worked by hand. The stores may be transferred on slings or in cargo nets, or in special trays known as "scaleboards". Obstructions in the vicinity of the dumps should be well fendered to protect both the ship's structure and the stores.

The method of passing, rigging, and working the gear is very similar to that for the light jackstay rig.

TRANSFER OF FUEL

Fuelling Abeam, Warship to Warship—Crane Fuelling Rig

Battleships, aircraft carriers and cruisers may be required to fuel destroyers and small escort vessels at sea. The abeam method is normally employed, and a typical rig for a battleship is shown in Fig. 278.

The hose is slung from the supplying ship's crane in two troughs called the inner and outer troughs. The outer trough is slung on the crane purchase, and the inner one on a $3\frac{1}{2}$ -inch manila whip, which is rove through a leading block half-way along the jib of the crane and thence through two leading blocks at deck level at the foot of the crane, where it is manned or taken to a winch.

A recovery line (of 2-inch F.S.W.R.) is shackled to the outer hose coupling, which is 15 feet from the end of the hose; it is used to take the weight of the end of the hose when offering the hose to the receiving ship or when recovering the hose after fuelling. This line is rove through a leading block at the jib-head of the crane and thence through two leading blocks at deck level at the foot of the crane, where it is manned or taken to a winch.

A hose line, consisting of 25 fathoms of $3\frac{1}{2}$ -inch manila, is shackled to a $2\frac{1}{2}$ -inch F.S.W.R. pendant, which in turn is shackled to the outer hose coupling; the hose line enables the receiving ship to haul the end of the hose aboard. When the end of the hose has been hauled aboard the receiving ship it is hung by a $2\frac{1}{2}$ -inch F.S.W.R. pendant which is hooked to the ring at the end of the hose line, the other end being put on a rigging slip which is secured to a point at least 8 feet above the deck. The outer length of the hose is lashed and clipped by spring hooks to the hose line, as shown in Fig. 279; it is unlashed and unclipped as soon as it is hauled aboard the receiving ship. To the end of the hose line is spliced a 30-fathom length of $1\frac{1}{2}$ -inch cordage, which serves as a messenger for passing the hose line to the receiving ship.

The hose is connected to the receiving ship's fuelling system by a quick-release coupling. Of the two parts of this coupling the male part is sent across by the supplying ship on the end of her hose, and the female part is provided by the receiving ship. The rate of pumping is controlled by each ship's fuelling officers, who communicate with each other by telephone.

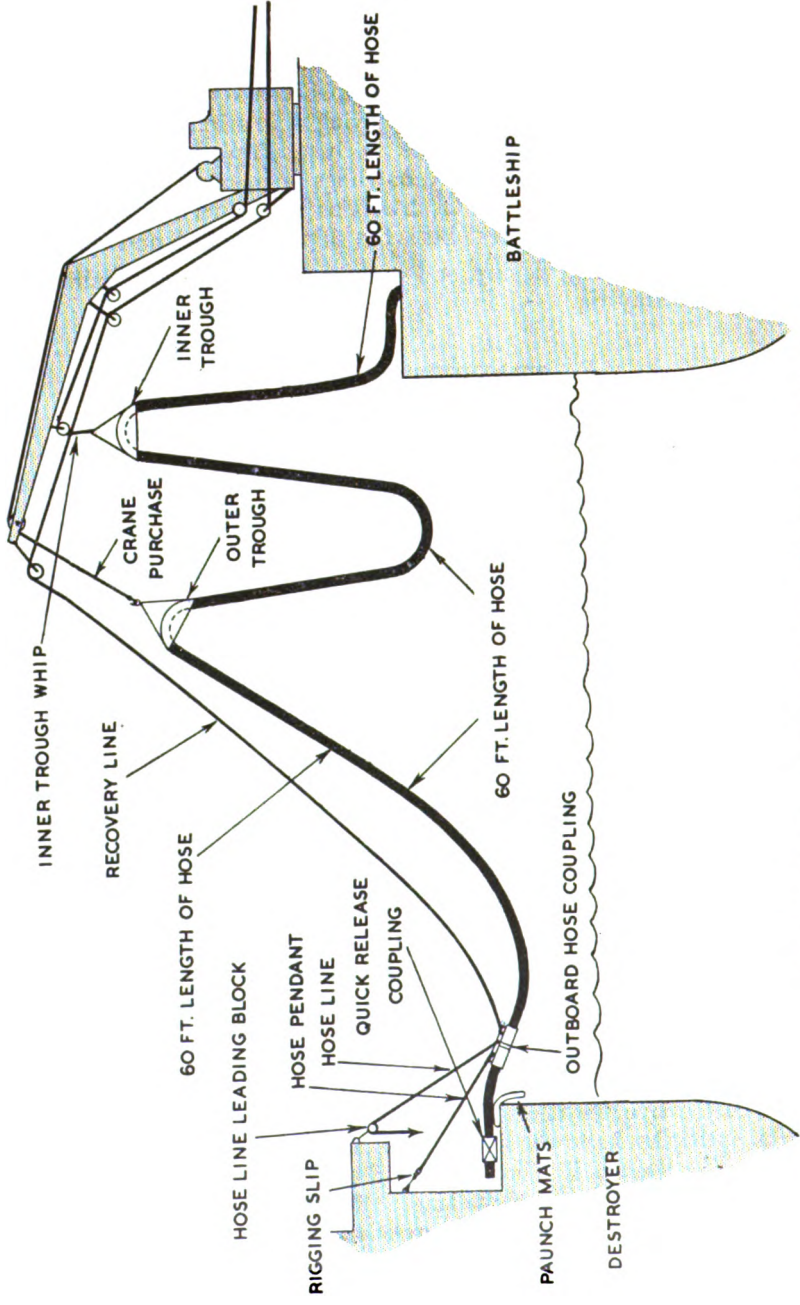


Fig. 278. Fuelling abeam, warship to warship—the crane fuelling rig

RIGGING THE GEAR IN SUPPLYING SHIP

Hoses are supplied in 30-ft. and 15-ft. lengths. Sufficient lengths are coupled together in the supplying ship to reach from a deck fuelling connection to the foot of her crane, at which point is coupled the outboard length of hose comprising five or six 30-ft. lengths and a 15-ft. length, on the outer end of which is the male half of the quick-release coupling.

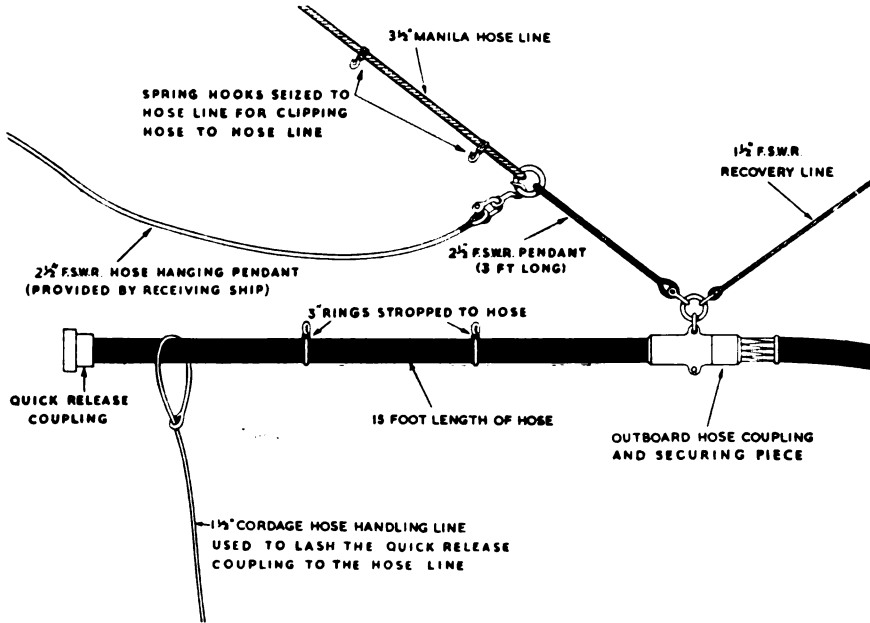


Fig. 279. Rig of end length of hose

The inner and outer troughs are placed, respectively, at about 60 feet and 120 feet from the inner end of the outboard length of hose. The hose is protected against chafe where it passes through the troughs by padded gaiters; these are laced round the hose, and the hose is securely lashed in the troughs while it is inflated to its full girth.

The recovery line and hose line are shackled to the outer coupling, and the end 15-ft. length of hose is lashed and clipped to the hose line.

The crane purchase is hooked to the slings of the outer trough, and the inner trough whip and recovery line are rove through their leading blocks. The recovery line and hose line are tended and the troughs are hoisted into position.

PASSING THE GEAR, AND RIGGING IT IN RECEIVING SHIP

The supplying ship passes the gun-line with the hose line messenger bent to it, and when the messenger is in hand in the receiving ship the supplying ship hitches the distance line, bridge telephone cable and fuelling telephone cable to the messenger, in that order. As the hose line is passed the crane is trained outboard.

When the hose line messenger is hauled aboard the receiving ship it is snatched into its leading block, which is placed at least 15 feet above the fuelling position; the distance line and telephone cables are unhitched and tended as they are hauled aboard. If the fuelling position is some distance from the bows

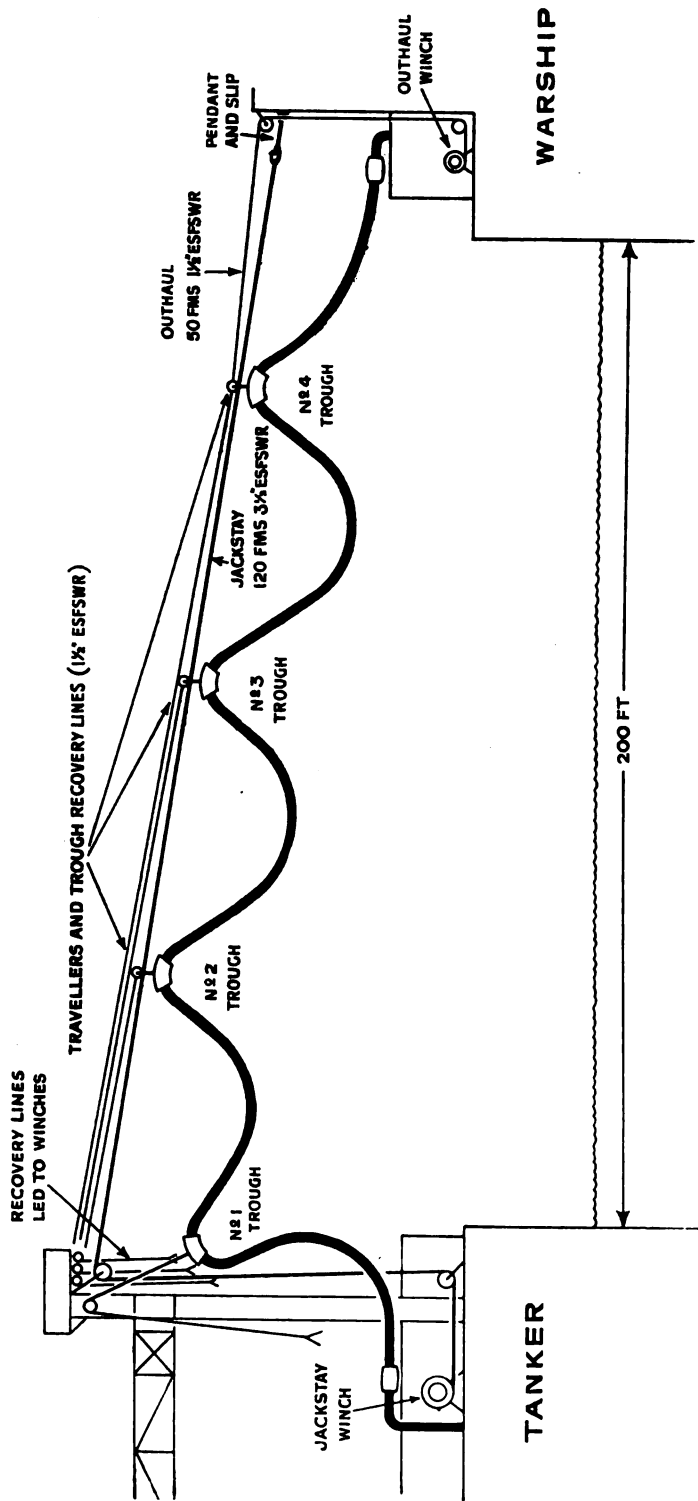


Fig. 280. Fuelling abeam from a tanker—the jackstay fuelling rig

of the ship, or if there is no clear run between them, the distance line is bent to a messenger, which is rove outboard of all from the bows to the fuelling position and hauled by the messenger to the position where it is to be tended.

The end of the hose is hauled over by the hose line, and as it comes inboard it is unlashd and unclipped from the hose line and hung by its pendant on the slip provided near the hose line leading block. The hose is then coupled to the receiving ship's fuelling system by the quick-release coupling, and lashed in place where it comes inboard. Shot mats are lashed over the gunwale and under the hose to protect it from chafe, and the hose is kept from working sideways by two tackles hooked to the links on each side of the outer hose connection.

WORKING THE RIG

While fuelling, the relative positions of the ships will be continually altering and the rig must therefore be tended in the supplying ship throughout the operation. The bights of the hoses should not be allowed to trail in the sea, and the crane should be trained in line with the lead of the hose to avoid any sideways stress on the jib-head. As the ships close each other the outer trough is raised and the jib topped up. As the ships open, the jib and outer trough are lowered; the inner trough will require little adjustment unless the ships have opened to nearly the full scope of the rig.

CASTING-OFF

After the quick-release coupling is uncoupled the slack in the hose line is taken down, and the end length of the hose is lashed and clipped to the hose line. The weight of the hose is then taken on the hose line, the hose pendant is slipped and unhooked, and the supplying ship takes the weight of the end of the hose on her recovery line as the hose line is paid back from the receiving ship. The telephone cables, gun-line and distance line are hitched to the hose line as it is paid out, the hose line being recovered in the supplying ship and hauled aboard with its messenger, which also is paid out by the receiving ship.

Fuelling Abeam from a Tanker—Derrick Fuelling Rig

Fuelling abeam from a tanker with the hose secured in troughs slung from one of her derricks is very similar in all respects to fuelling abeam from a warship. The tanker's hose is slung by three troughs from one of her derricks, otherwise the rig is similar to the crane fuelling rig. The methods of passing and recovering the gear, and of rigging and securing it in the receiving ship, are the same. This is the usual rig for fuelling destroyers and other small ships; larger ships are fuelled from a tanker by the jackstay fuelling rig described below.

Fuelling Abeam from a Tanker—Jackstay Fuelling Rig (Fig. 280)

The jackstay rig enables ships to be fuelled abeam at a greater distance from the tanker than with the derrick rig, and is usually employed for fuelling cruisers and larger warships.

The rig consists of a 3½-inch E.S.F.S.W.R. jackstay, 120 fathoms in length, which is rigged from the tanker to the warship. The standing end is secured to a slip in the warship, and the hauling end is worked in the tanker by a self-rendering winch from which it is rove through leading blocks at the head and foot of one of her kingposts. The hose is lashed in four troughs, of which one is triced to the head of the kingpost and the other three slung on travellers

which run along the jackstay. To each traveller is shackled a $1\frac{1}{2}$ -inch E.S.F.S.W.R. recovery line, which is rove through leading blocks at the head and foot of the kingpost and thence led to a winch. To the outer traveller is shackled a $1\frac{1}{2}$ -inch E.S.F.S.W.R. outhaul, 30 fathoms in length, which is rove through leading blocks in the warship and thence to one of her winches ; by hauling on the outhaul the travellers and their troughs, with the hose, are run out along the jackstay.

On the standing end of the jackstay is shackled a monkey-face, to one eye of which is shackled a short $3\frac{1}{2}$ -inch E.S.F.S.W.R. pendant by which the jackstay is secured to its slip, and to the other eye of which is shackled the jackstay line, which is used to haul the jackstay across from the tanker after initial contact has been established ; the jackstay line is similar in all respects to the hose line of the crane and derrick rigs. The end of the outhaul is stopped to the monkey-face on the end of the jackstay, and the end of the hose is secured to a cut splice and thimble fitted in the outhaul at a point about 20 feet from the outer traveller.

WORKING THE RIG

Contact is established, and the lines are passed from the tanker to the warship in the same way as when using other rigs. The jackstay is hauled across and secured to its slip in the warship, and the outhaul is rove through its leading blocks and taken to a winch. The travellers and hose are then hauled across by the outhaul, the hose is unclipped from the outhaul and connected to the warship's fuelling system, and the outhaul is belayed.

When fuelling is completed the hose is disconnected and its end clipped to the thimble and cut splice in the outhaul. The tanker then hauls in the travellers, together with the hose, by their recovery lines, and the outhaul is unrove and its end stopped to the monkey-face of the jackstay. The jackstay is then slipped and paid back to the tanker on the jackstay line, together with the other lines.

Fuelling Astern from a Tanker—the Astern Fuelling Rig

The tanker streams from her stern a length of hose, which is buoyant and to the end of which is attached a manila hose line ; on the end of this line is a float which helps to keep it near the surface. The receiving ship then closes the hose line, grapples it, and with it hauls in the end of the hose over her bows and connects the hose to her fuelling system. The length of hose streamed by the tanker depends on the weather ; about 80 fathoms are streamed in calm weather and about 110 fathoms in rough weather.

The tanker also streams a fog buoy, called the " marker buoy ", on which the receiving ship keeps station by keeping it abreast her bridge. The distance to which the marker buoy is veered is adjusted to allow a deep bight in the hose when it is connected ; this bight absorbs any slight errors in station-keeping.

RIG OF THE HOSE

A securing-piece with four lugs is inserted in the hose at 15 feet from its end. A $2\frac{1}{2}$ -inch F.S.W.R. hose-hanging pendant, 20 feet long, is shackled to the securing-piece and stopped to the end length of hose, and to its end is shackled the 50-fathom hose line of $3\frac{1}{2}$ -inch manila ; a strong becket for hanging the hose line is spliced into it 50 feet from the end nearest the float. On the end of the hose is fitted a 6-ft. haul-about line of $2\frac{1}{2}$ -inch manila with which the hose is man-handled as it is hauled through the hose fairlead of the receiving ship.

ESTABLISHING CONNECTION BY GRAPNEL

The receiving ship closes the hose line and grapples it with two grapnels, each of which should be tailed with about 10 fathoms of 2-inch manila. The grapnels are cast well forward and outboard across the hose line, which will be running about 2 or 3 feet below the surface. When grappled, the bight of the hose line is brought in over the bows through the hose fairlead and the float is hauled in over the guard-rails. As much as possible of the hose line is hauled in by hand as the receiving ship moves up to the fuelling position.

When the end of the hose is abaft the fairlead the hose line is brought to the capstan and the end of the hose is hove up to the lip of the fairlead, care being taken not to put too much strain on the hose line as it is hove in.

The end of the hose is then guided through its fairlead with its haul-about line, and hung by its pendant on a senhouse slip secured to a deck clench before the capstan. The end of the hose is then coupled to the receiving ship's hose by a quick-release coupling, and the signal to start pumping is passed to the tanker (see Fig. 283).

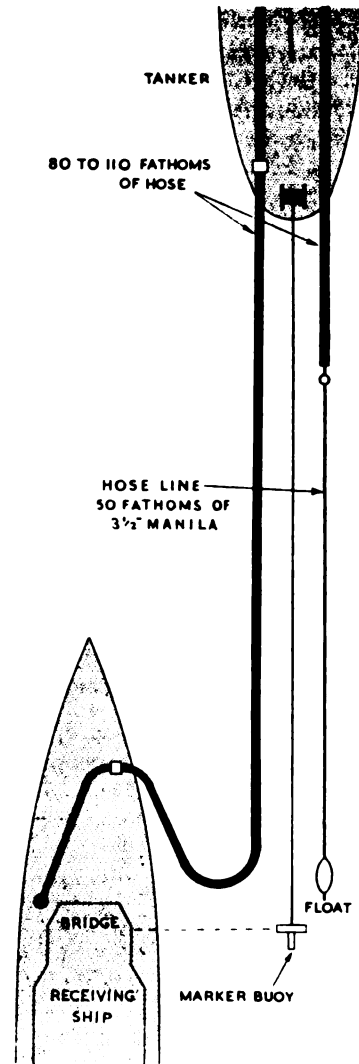


Fig. 281. Fuelling stern from a tanker —the astern fuelling rig

ESTABLISHING CONNECTION BY GUN-LINE (Fig. 282)

Grappling the hose line at speeds of over 8 knots may be difficult, and an alternative method of establishing contact is to pass the hose line from the tanker by means of a gun-line. With this method the tanker streams the hose but retains the end of the hose line, thus streaming the hose and its line in a bight. The length of the hose line is about 35 fathoms longer than the length of hose streamed, and it is fitted with a becket about 20 fathoms from the end nearest the hose. To the end of the hose line is shackled a $2\frac{1}{2}$ -inch manila messenger, 40 fathoms in length.

The receiving ship closes the quarter of the tanker and the gun-line is passed. To this is hitched a light messenger which, in turn, is bent to the end of the hose

line. The end of the hose line is then hauled in by the receiving ship as it is paid out from the tanker on the 2½-inch messenger. As the hose line is hauled across, the receiving ship steers out so as to keep the bight of the hose line clear of her side and her propellers. The light messenger and the gun-line are coiled and hitched to the messenger.

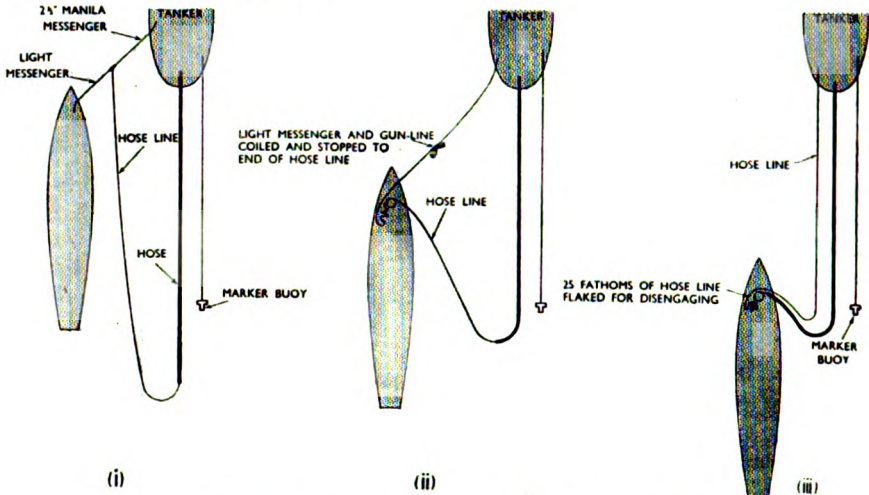


Fig. 282. Fuelling astern—forecastle arrangements in receiving ship

The receiving ship then drops astern, hauling in the after end of the hose line and paying out the messenger and the forward end of the hose line back to the tanker. When the end of the hose is hauled on board and connected, about 25 fathoms of the hose line should be kept in the receiving ship for use when casting off.

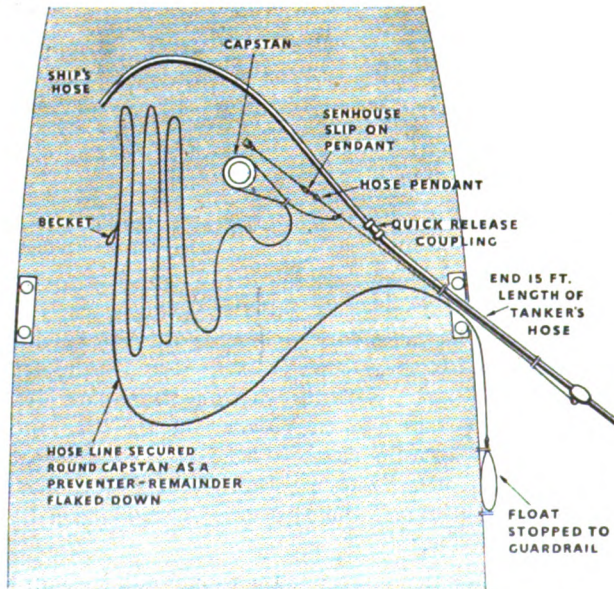


Fig. 283. Fuelling astern—establishing connection by gun-line

PREPARATIONS IN RECEIVING SHIP FOR CASTING-OFF (Fig. 283)

The hose and its gear must be cast off so that they will stream clear of the receiving ship's side and her propellers. They must also be in good order and ready in all respects to be grappled by, or passed to, the next ship to refuel; any defects in the gear must therefore be made good in the receiving ship while she is refuelling, and any defect which cannot be made good must be reported to the tanker.

The hose line is flaked for running abaft the capstan and on its disengaged side, and its becket is stopped securely to it to prevent it from being fouled as it passes round the capstan. If the line has been grappled the end fathom with the float is stopped securely to the guardrail immediately abaft the hose fairlead.

CASTING-OFF

The hose is uncoupled, its cap replaced, and the end length is lashed to the hose pendant. The hose line is brought to the capstan and the weight of the hose is taken off the hose pendant by the hose line. The hose pendant is then slipped and secured to the hose line, and the end of the hose is veered handsomely on the hose line through the hose fairlead and into the water. As the hose line is veered the bight in the hose will decrease, thus reducing the strain on the hose line, and when the becket in the hose line is abreast the slip there will be little strain in the line. The becket is then put on the senhouse slip, the hose line is taken off the capstan, and its bight is passed out through the hose fairlead. If the hose has been grappled a hand is detailed to cut the stops on the end of the hose line and the float. The becket is then slipped and the hose line and float should stream clear of the ship.

Fuelling Astern from a Warship

The larger warships may be equipped for fuelling a ship astern of them, a typical arrangement for which is shown in Fig. 284.

About 450 feet of hose is provided by the supplying ship and streamed in three or more fleets, according to the space available for laying it out.

The first fleet must be started out, but the others should stream by their own weight and the drag of the water. As the inner end of each fleet reaches the hose fairlead it is hung on a hose pendant and coupled to the outer end of the next fleet with a securing-piece. The inner end of the last fleet is hung on the hose pendant and coupled by a quick-release coupling to a length of hose leading from the supplying ship's after fuelling connection.

RIGGING THE GEAR

A "starting-out pendant" of 1½-inch F.S.W.R., fitted with a hook, is rove through a leading block situated just before the hose fairlead and brought to the after capstan. An easing-out pendant of 2½-inch F.S.W.R., which also serves as a recovery pendant when recovering the hose, is rove through leading blocks and taken across the deck to any conveniently situated bollards.

The end length of hose is rigged in the usual manner, and the hose line is led out through the hose fairlead, stopped to the upper guardrail, led inboard through the after fairlead on the other side, flaked down, then led outboard through the same fairlead and stopped with its float to the guardrail before the fairlead.

The hose-hanging pendant with its rigging slip is shackled to a deck clench about 15 feet before the hose fairlead.

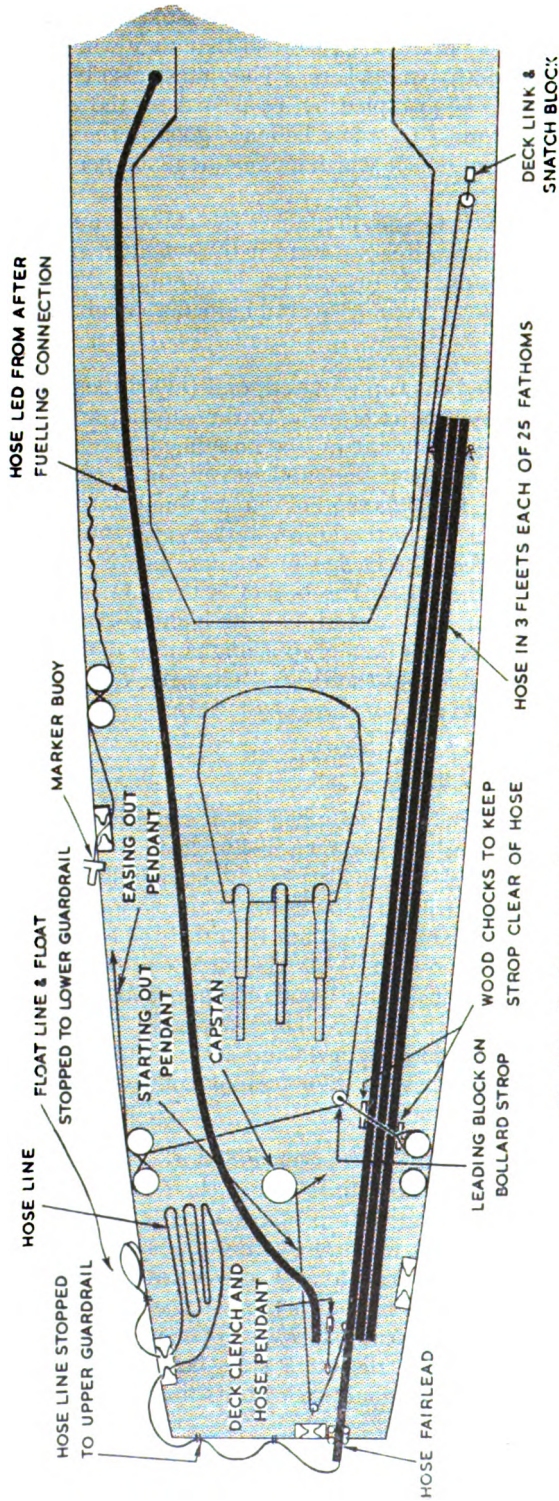


Fig. 284. Fuelling astern from a warship—arrangements in supplying ship

The fog buoy and its tow-rope are prepared for streaming through a fairlead on the opposite side to the hose.

STREAMING THE HOSE

The float and the hose line are streamed, the hose is then started out by the starting-out pendant, the easing-out pendant being surged as required. When the inner end of the first fleet is near the hose fairlead it is hung on the hose pendant while it is coupled to the next fleet. The easing-out pendant is then shifted to the inner end of the next fleet of hose, which is streamed in a similar manner. The starting-out pendant is not used when sufficient hose has been streamed for the water to grip the hose and drag it out.

When the inner end of the last fleet of hose is near the hose fairlead it is hung on the hose pendant and then coupled by a quick-release coupling to the length of hose rigged from the supplying ship's after fuelling connection. When the hose is streamed it is usually inflated to enable it to float.

The fog buoy is then streamed as a marker buoy, with a length of tow of about 80 fathoms.

RECOVERING THE HOSE

The hose is hove in by the recovery pendant, which is brought to the after capstan. As the outer end of each fleet is brought aboard the hose is hung on the hose pendant and the fleet uncoupled from the next one. The recovery pendant is then transferred to the inner end of the next fleet, which is hove in in a similar manner.

When the last fleet has been recovered the hose line is run in through the after fairlead, and the float is recovered over the guardrails.

CHAPTER XIII

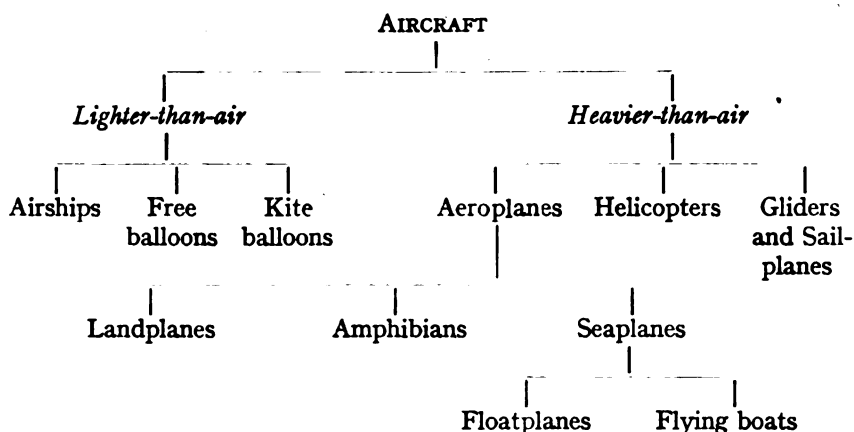
Aircraft

A SEAMAN should have sufficient knowledge of aircraft to enable him to carry out any of the following operations :—

- (i) embarking and disembarking aeroplanes, both when the ship is alongside or at anchor ;
- (ii) handling and stowing aeroplanes in a ship ;
- (iii) attending in boats on seaplanes when they are taking-off, alighting, taxiing, or at their moorings ;
- (iv) taking in tow a disabled seaplane ;
- (v) rescuing the crew of an aircraft which has crashed in the sea.

Types of Aircraft

The term aircraft includes all types of airborne craft, both "lighter-than-air" and "heavier-than-air", as shown in the following table.



In this chapter only aeroplanes are described because it is with aircraft of this type that the seaman will normally be required to deal.

Structural Details

For descriptive purposes an aeroplane can be considered as being divided into two main parts, the "power plant" and the "airframe". The power plant comprises the engine (or engines) and its (or their) accessories. The chief parts of the airframe are : the "landing gear", *i.e.* the undercarriage and its accessories and the tail wheel ; the "fuselage" or main body of the aeroplane ; the "wings" or "main planes" with their "centre-section" between them ; the "tail plane" ; the "fin" ; and the "control surfaces", comprising the "ailerons", "elevators" and "rudder".

The structure of the airframe is built of light metal alloys in tubular or girder form, and it is covered either with linen fabric, or with sheet metal about thirty-thousandths-of-an-inch thick. The structure and its surfaces are amply strong to withstand the stresses of flying, alighting, and taxiing on the ground or water, but because of their light construction they may be easily damaged if mishandled.

Certain parts of the structure and surfaces of the airframe are therefore specially strengthened to withstand the stresses to which they may be subjected when the aeroplane is handled or manoeuvred on the ground or the water, and these places are usually marked by lettering, arrows, or lines, painted over or near them.

When an aeroplane has to be manhandled it may also be pushed or hauled at the following places :—

- (i) the undercarriage ;
- (ii) the "catapult spools" (if fitted) ;
- (iii) the wing-tips ;
- (iv) the leading edges of the main planes and tail plane.

Footrests are usually provided for climbing into or on to the aeroplane, and as a general rule it is safe to walk in rubber-soled shoes on the surfaces of the roots of the wings, *i.e.* on that part which lies within about 18 inches of the fuselage.

Any projections from the fuselage or planes, such as the radio and radar aerials and the "pitot-head", should not be touched. (The pitot-head consists of two small tubes, projecting about 9 inches from the leading edge of a wing, by means of which the speed of the aeroplane is registered).

Control Surfaces and Controls (Fig. 285). An aeroplane is controlled when in the air, and to a certain extent when on the ground or the water, by its control surfaces. These control surfaces are hinged extensions of the main planes, tail plane, and fin, and they comprise :—

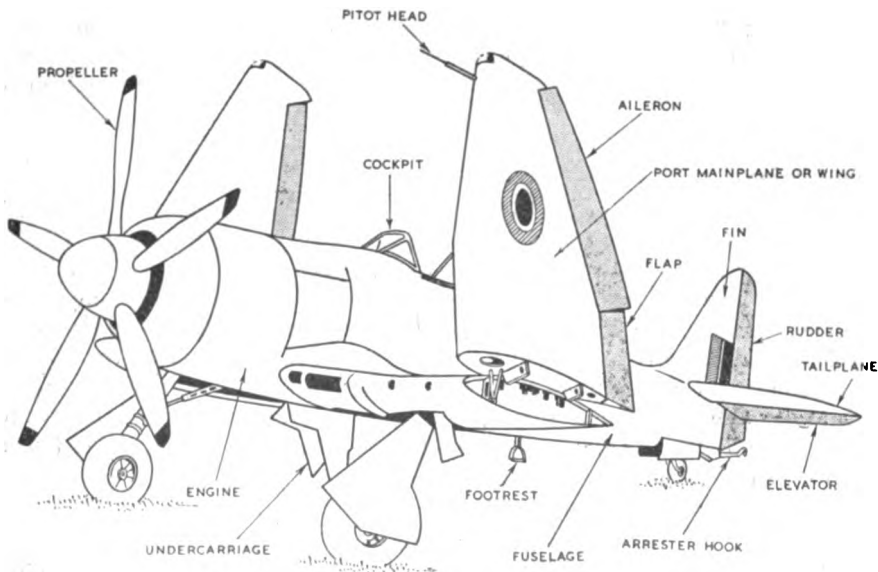


Fig. 285. Parts of an aeroplane

- (i) the elevators, by which the aeroplane can be made to fly level in a fore-and-aft sense, or climb or dive ;
- (ii) the ailerons, by which it can be made to fly level in an athwartships sense, or " bank " (i.e. heel) to starboard or port ;
- (iii) the " rudder ", by which it can be made to fly on a steady course, or slew to starboard or port.

In addition to these control surfaces an aeroplane may have " flaps " to reduce its speed when alighting and increase its lift when taking-off. All these surfaces are of vital importance to the aeroplane when in flight, and when handling an aeroplane every care should be taken to ensure that they are not damaged.

These control surfaces are connected by " kingposts ", " rods ", and " control wires " to the " control column " in the pilot's cockpit. No unauthorised or unqualified person should be allowed to enter the cockpits or the cabin of an aeroplane except under the supervision of a properly qualified person, and no unqualified person should be allowed to interfere with the controls.

Stowage

The wings of most carrier-borne aeroplanes are designed to fold so that the planes can be stowed as close together as possible in the carrier's hangars, or on her flight deck. The wings can be spread or folded either by a mechanism operated from the pilot's cockpit, or by hand ; in each case this should be done under the supervision of a qualified person.

When securing an aeroplane on board a ship allowance must be made for the stresses imposed on it when the ship pitches or rolls in a seaway ; it should also be prevented from moving in its fore-and-aft direction, but should not be held down too rigidly, otherwise its structure may be strained. The securing arrangements consist of chocks for the wheels, and wire rope cables led from various points of the airframe to deck link-plates (similar to ringbolts). These cables are usually fitted with bull-dog grips and a bottle-screw so that they can be adjusted ; they have a quick-release slip at one end, and are set up by the bottle-screws to allow the sprung undercarriage of the aircraft a certain amount of play. The chocks are lashed or locked in pairs on each side of each main wheel.

Manoeuvring

Whenever an aeroplane is being moved in a confined space a " tail-arm " should be shipped on the tail wheel ; it functions like a tiller and the aircraft can be manoeuvred with it very precisely. When the aeroplane is being manoeuvred hands should be stationed at each main wheel with chocks for stopping the aeroplane when ordered, or in an emergency, and whenever practicable a qualified airman should be in the pilot's seat to operate the brakes. Light aircraft are manoeuvred by man-handling, but heavy aircraft are either taxied by qualified airmen, or towed, nose or tail first, by tractors. The forward towing point is usually the undercarriage, and the after towing point (when fitted) is in the vicinity of the tail wheel.

Slinging

Ship-borne aeroplanes are designed with specially strengthened slinging points and provided with slings so that they can be hoisted into or out of ships.

In biplanes the slinging points are usually at the four corners of the upper centre-section. A monoplane is usually slung from points either side of the fuselage and near its centre of gravity, and steadying lines are led to the catapult spools (see Fig. 286).

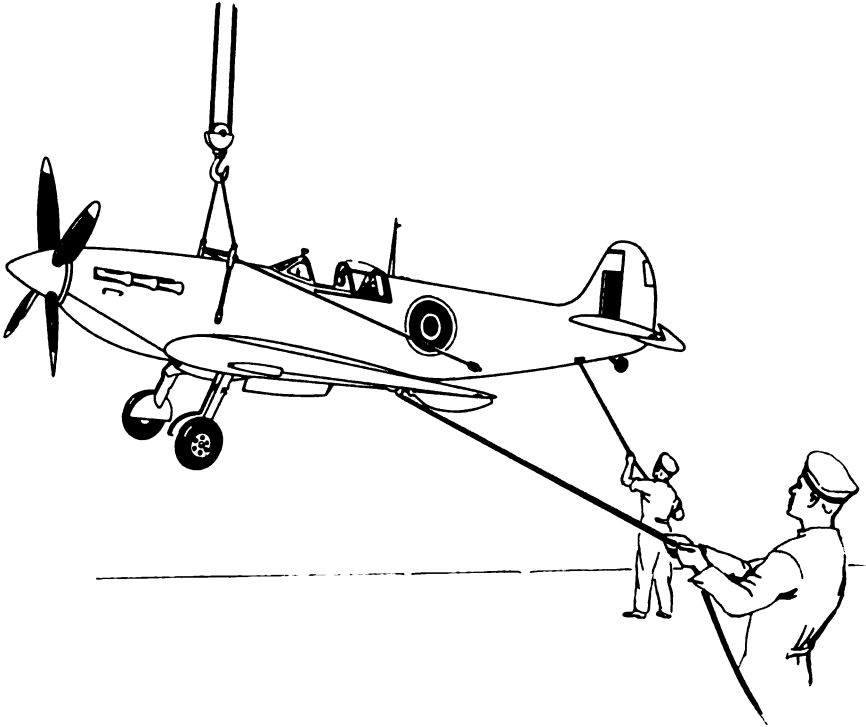


Fig. 286. Hoisting an aeroplane

When an aeroplane is being hoisted into or out of a ship steadying lines should be provided. If the wings are folded, one line should be bent to a leg of the undercarriage and another to a point well aft and near the tail wheel. If the wings are spread the aeroplane is very liable to swing and slew when hoisted, particularly in a wind, so an additional steadying line should be bent to one wing-tip, or one to each wing-tip if necessary.

If slings and slinging points are not provided they should not be extemporised without expert advice, because an aeroplane may easily be strained if it is incorrectly slung. If, however, no expert advice is available and it is necessary to hoist an aeroplane not provided with slings or slinging points, the extempore method described below (and illustrated in Fig. 287) may be used.

It should be borne in mind that the strongest parts of an aeroplane are on the fuselage, at the attachment-points of the undercarriage and wings and at the catapult spools, and that the centre of gravity of the aeroplane lies usually between the centre-line of the wings and their trailing edges. Two spars should therefore be lashed below the fuselage and athwartships so that they bear under the forward and after attachment-points of the wings. Two more spars should then be lashed fore-and-aft to the underside of the first two spars, one each side

of the fuselage and just clear of it. A four-legged sling should then be made up and its four legs be secured to the ends of the two fore-and-aft spars; if necessary the legs should be separated by spreaders so that they clear the wings and fuselage. Steadying lines should be rigged from the slings to the catapult spools on each side of the fuselage. The work will be simplified by first removing the wings, but this may be impracticable.

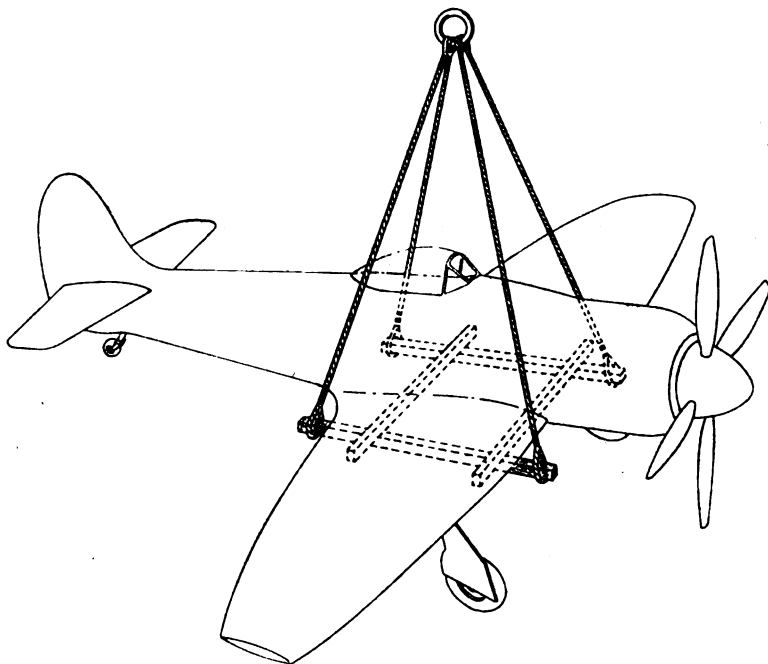


Fig. 287. Extempore method of slinging an aeroplane

Transporting by Water

Landplanes are usually transported on water by flat-topped barges. It should be borne in mind that the additional top-weight of the aeroplane may make a barge very "tender", so when practicable the barge should be suitably ballasted before loading her with aircraft. The aeroplanes may have to be stowed on the deck of the barge in such a manner that parts of them project over her sides, so the embarking ship should provide catamarans of sufficient width to fend off the barge so that its cargo is well clear of the ship's side.

Attending on and Towing Seaplanes

Attending on Seaplanes by Day.—Whenever practicable a power boat should be used in preference to a pulling boat for attending on seaplanes. If a choice of power boats is available it is better to use a slow boat which is easy to manœuvre at low speeds rather than a fast boat which is difficult to handle at low speeds. If the boat is to attend on seaplanes when they are taking-off or alighting she should carry, in addition to her crew, an air mechanic and a sick-berth attendant, together with the following gear :—

- first-aid outfit ;
- a " crash box " containing wire cutters (long and short handled), shears, saws, axes and hatchets, and leather gloves ;
- four 2-gallon foam units ;
- two chain-tailed 9-lb. grapnels ;
- and an Aldis lantern.

When attending on seaplanes while they are taking-off or alighting the boat should fly flag " Fox ", and the operating ship should fly the same flag at her yard-arm. If the seaplane is about to take off the boat should be stationed up-wind, clear of the seaplane's path and abreast the estimated position at which it will leave the water. If the seaplane is about to alight the boat should be stationed, clear of its path, about 200 yards up-wind from the estimated position at which the seaplane will first alight.

Attending on Seaplanes at Night.—Normally, seaplanes are operated at night under the direction and supervision of qualified officers and men using standard equipment, in accordance with the Regulations for Naval Aviation. As, however, the advice of qualified officers and the supply of standard equipment may not always be available, the following notes on this work are given here.

An experienced seaplane pilot can alight at night with no other aids than a small searchlight or signal projector trained exactly in the direction from which the wind is blowing, and the normal illumination afforded by the lights shining out from the side scuttles and upper deck of a ship at anchor. In these circumstances the attendant boat should wait alongside the accommodation ladder and keep her engines running, and the coxswain should be at the gangway ready to receive any orders from the Officer of the Watch. The seaplane will probably alight at from 50 to 100 yards astern of the ship if the latter is swung into wind, and will finish its run approximately abreast the bows of the ship. The searchlight should be switched on when the ship is ready for the seaplane to alight, and be dowsed when the seaplane has alighted.

In other circumstances, an extempore " flare-path " consisting of three or more mark boats, of which two should be power-driven, can be laid out as shown in Fig. 288.

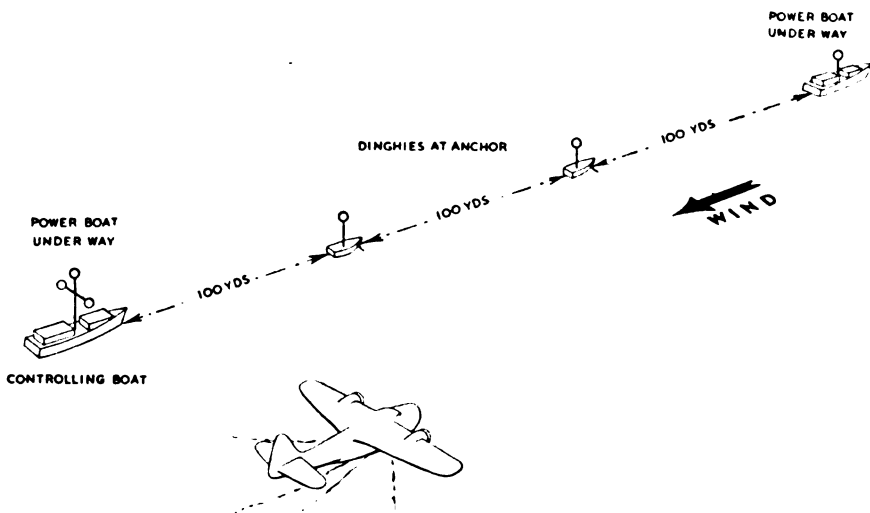


Fig. 288. Extempore flare path for seaplanes

Each boat is fitted with a mast about 10-ft. high, on which is hoisted an all-round white light capable of being switched on or off. The mast of the leeward boat is fitted with a yard, at each arm of which is hoisted an all-round white light which also can be switched on or off. The leeward boat should be the controlling boat, and all should be stationed 100 yards apart in a straight line parallel with the direction of the wind. The length of the flare-path should be not less than 200 yards, and 400 to 500 yards long should suffice for most occasions. The direction of the flare-path should lie within 10 degrees of the direction of the wind, and there should be no obstruction above sea level within at least half-a-mile to windward or to leeward of its ends. All boats except that at each end of the flare-path should be anchored and manned by boat-keepers. If the direction of the wind changes, the line of the flare-path should be similarly changed by orientating the flare-path about the centre boat.

The controlling boat should maintain communication with the seaplane by means of an aldis lantern fitted with red and green shades. A green light is displayed to indicate that the flare-path is ready for use, and a red light to indicate that the flare-path should not be used. The display of all three of the controlling boat's white lights indicates that either the starboard or the port side of the flare-path may be used. If one of the yard-arm lights is switched off, that side of the flare-path must not be used. For security purposes the lights may be screened to show only to leeward over a horizontal and vertical arc of 15 degrees.

Towing.—When adrift a seaplane usually heads to windward, and drifts to leeward much faster than a boat; a boat intending to take it in tow should therefore approach it from windward. The tow-rope should be bent to the mooring bridle of the seaplane, which in a float plane is usually secured to the forward ends of the floats, and in a flying boat to lugs on the stem or in the head sheets. When close aboard, the seaplane should be fended off by hand and boathooks should not be used for grappling it as they may easily damage its structure. If the seaplane is manned, the tow-rope can be passed from windward on a heaving line; or, if this is not practicable, a grass line may be streamed to leeward of the seaplane so that the seaplane will drift over it and thus enable the tow-rope to be passed on the grass line.

A seaplane under tow may yaw very considerably, and to prevent this steadying lines should be secured to each wing tip and tended in the sternsheets of the towing boat.

A seaplane should be towed at short stay, the length of tow being adjusted so that the bows of the seaplane ride on the third wave of the wash. If towed at long stay the weight of the tow-rope will tend to submerge the bows of the seaplane. The speed at which a seaplane may be towed depends upon sea and weather conditions, but a floatplane should never be towed at over 7 knots, and a flying boat never at over 15 knots. The choice of rope used for towing will depend upon the size of the aircraft and the conditions under which the tow is to be carried out; $2\frac{1}{2}$ -inch E.S.F.S.W.R. should be strong enough for towing a large flying boat for any distance in the open sea, whereas a 2-inch manila should suffice for towing small float planes in harbour.

Attending a Seaplane Under Way.—In calm weather, passengers, baggage, and stores can be embarked while under way from the sternsheets of the attendant boat over the bows of a flying boat and they can be similarly disembarked from the flying boat. The attendant boat, with her stern and

quarters well fendered, should steer on a steady course into the wind at slow speed (about 4 to 5 knots). The flying boat should then be manoeuvred close enough to either quarter of the boat for the embarkation or disembarkation to be carried out. Throughout the manoeuvre the flying boat should keep station on the attendant boat.

Attending a Seaplane Moored to a Buoy.—To transfer stores, fuel, baggage, or passengers from a boat to a seaplane moored to a buoy, the boat should secure to the buoy and no attempt should be made to go alongside the seaplane or make fast to it. The seaplane should then ride with sufficient scope on its bridle to allow the boat to lie between the buoy and the seaplane. When approaching the buoy care should be taken to avoid fouling the seaplane's bridle with the boat's propeller, and when the boat is secured the bridle should be grappled and stopped to her gunwale.

A seaplane is of very shallow draft and has a large windage area, so the direction in which it may lie to its moorings will be governed more by the wind than by the tidal stream; a seaplane is also liable to yaw violently at its moorings, particularly in a gusty wind. A boat should therefore be handled with more care than usual when securing to a buoy at which a seaplane is moored. She should approach from abeam or before the beam of the seaplane, and then turn up-stream to secure to the buoy. If there is no tidal stream she should turn up-wind to secure.

After securing the boat to the buoy and protecting her stern and quarters with fenders, a stern fast should be passed from the boat to the seaplane so that the boat can be warped close to the plane for the transfer of passengers and cargo by hauling in or veering the boat's painter and the seaplane's bridle.

Rescuing Crashed Aircraft

When an aircraft crashes into the water the first duty of the rescue boat is to save the passengers and crew. Modern land planes will probably sink within five minutes of crashing, and speed in rescue operations is therefore essential.

If the occupants have had sufficient warning they will probably have cast off their securing harness, and have released the dinghy which aircraft carry when flying over the sea. They would probably also have inflated their life-jackets and should therefore be floating near the wreckage.

The occupants may, however, be unconscious and either trapped within the aircraft or entangled in wreckage below the surface. The first survivor rescued should, if conscious, be asked the number and probable whereabouts of any other occupants. Passengers and crew are secured to their seats by webbing harness which passes over their shoulders, or by leather belts around their waists; these have quick-release devices, but it is simpler to cut them with a sharp knife. If there is a good swimmer in the boat's crew he should be detailed to take his knife and any suitable tools from the crash box, secure a line around his body with a bowline and pass the end to another of the crew, and then stand by to dive in and rescue anyone trapped in submerged wreckage.

If the crashed aircraft is on fire the water surrounding it will probably be so widely covered with burning petrol that the rescue boat cannot approach close aboard. The boat may, however, be able to rescue anyone thrown clear and floating on the fringes of the fire, and for this purpose she should have ready a grapnel tailed with chain. If the fire is small it may be possible to approach

the aircraft from up-wind close enough to grapple it and tow it clear of the burning petrol, all available fire extinguishers being played on any burning petrol in the boat's vicinity.

The wreckage of an aircraft may be of great value in determining the cause of an accident ; otherwise it is of little value and, unless orders to the contrary have been received, it should be sunk in deep water. Care should be taken to leave no traces of floating wreckage, because these may subsequently be found or washed ashore and lead to unnecessary search or rescue operations. If the wreckage is to be recovered the best places at which to secure the tow-ropes, strops, or slings, are : the propeller-boss, the roots of the main planes, the catapult spools, and the lugs for the mooring bridle (if fitted).

CHAPTER XIV

Notes on Damage Control and Ship Stability

DAMAGE CONTROL

THE precautions for safeguarding a ship and her crew against shipwreck, fire, and the hazards of all forms of modern warfare, together with the action necessary to control or repair any damage to the ship, are known collectively as "A.B.C.D.," these being the initial letters of the terms atomic, biological and chemical protection and damage control. Protection against A.B.C. warfare and the control of damage in a ship are directed by an executive officer known as the "A.B.C.D. Officer", and they are controlled from a base in the ship called the "A.B.C.D. Headquarters".

Detailed and complete instructions for A.B.C. protection and damage control are contained in the *Ship ABCD Manual*, and this chapter is intended to introduce the seaman to the more important aspects of the last category only of A.B.C.D., namely that of damage control.

Organisation

The organisation for damage control varies with the size and type of ship ; for example, the organisation for a destroyer is not nearly so complex as that required for a fleet carrier. Fig. 289 shows the layout of the organisation for a cruiser, this being a fairly simple example.

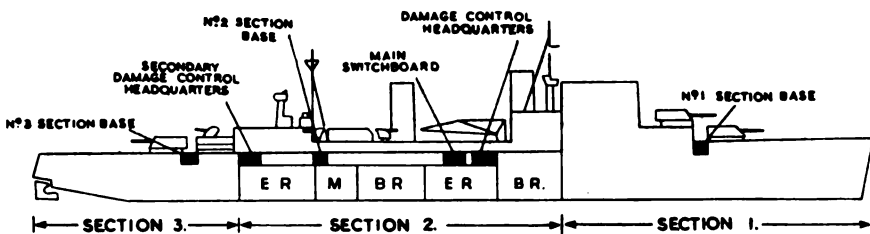


Fig. 289. Typical subdivision of a cruiser for damage control purposes

HEADQUARTERS, BASES AND SECTIONS

From Fig. 289 it will be seen that for damage control purposes the interior of the ship is divided vertically and athwartships into three sections, numbered 1, 2 and 3. The damage control arrangements in each section are controlled from its own base, and each base is controlled from a centre known as the A.B.C.D. Headquarters (H.Q.1). The H.Q.1. is situated centrally in the ship, in the vicinity of the main switchboard. There is a secondary headquarters (H.Q.2), from which the organisation is controlled if the H.Q.1. is put out of action ; it is situated at some distance from the H.Q.1. in the vicinity of the "Secondary Electrical Position" (E.P.2).

COMMUNICATIONS

The various compartments and control positions in each section are connected by telephone with their respective bases, and some of them are connected

directly with H.Q.1 and H.Q.2 as well. The three bases are connected by telephone with the H.Q.1 and the H.Q.2, and with each other. This telephone network is divided into three separate systems, one being for matters concerning fire and general damage, one for electrical equipment and circuits, and the third for pumping and flooding; the hand sets for these three systems are distinctively coloured: *red* for fire and general damage, *green* for electrical equipment and circuits, and *yellow* for pumping and flooding.

In addition to these telephone systems a special broadcast system may be installed which can be controlled from either of the two headquarters.

CONTROL AND MANNING

In ships larger than destroyers the organisation is controlled from H.Q.1 unless the possibility of enemy action is very remote, when it may be controlled by the Officer of the Watch.

The extent to which damage control stations are manned depends upon the degree of probability of enemy action. When action with the enemy is imminent or highly probable the stations are fully manned with special parties. In H.Q.1 there is a team of officers and men trained and equipped to assess the effects, and organise the repair, of all types of damage which may occur, also to take such other counter measures as are necessary to ensure the safety of the ship. In each section there is a composite team of ratings who are trained and equipped to take immediate and appropriate action to deal with any type of damage in their section as soon as it occurs; each of these teams is controlled by an officer stationed at the sectional base, and each includes "fire and repair parties", "pumping and flooding parties", "supply and first-aid parties", "electrical repair parties", and "W.T. integrity patrols". Each team works as a unit within the limits of its section, but in the event of serious damage H.Q.1 may order one section to be reinforced by men taken from the other sections.

When action with the enemy is less probable, damage control stations are only manned with skeleton teams, and when the probability is remote, when the ship is lying in a safe and defended anchorage for example, no stations may be manned and any damage control requirements would then be provided by the ship's emergency party.

States of Readiness

The five different "states of readiness" which can be assumed by the damage control organisation are described in the table on page 485. These states will not necessarily coincide with the four different "degrees of readiness" which may be assumed by the armament organisation, because the latter are controlled by active defence or offence requirements. For example, if the ship were steaming in waters where the probability of air or surface attack was remote but in which mines might well be encountered, her damage control organisation would be in *State II* whereas her armament would be in the *Fourth Degree*. Another reason for this difference is that the change from one state of readiness to another may take as long as half-an-hour because considerable changes in the state of the ship's machinery and equipment may be involved, whereas the change from one degree of readiness of the armament to another can be effected in a few minutes.

Water-tight Conditions

The water-tight openings of a warship are described as being in one of three "conditions" of water-tightness, as follows:—

STATES OF READINESS AND WATER-TIGHT CONDITIONS

STATE OF D.C. READINESS	CIRCUMSTANCES IN WHICH ASSUMED	WATER-TIGHT CONDITION	REMARKS
I	Attack imminent ; <i>e.g.</i> enemy ships or aircraft approaching.	Z	All damage control parties closed up and positions manned.
II	Attack likely ; <i>e.g.</i> in submarine or mine areas, or within range of likely air attack.	Z or XY	Damage control parties in two watches and key positions manned. W.T. patrols active.
III	Attack possible ; <i>e.g.</i> outside range of likely air attack, but within possible submarine or mine areas.	XY	Damage control positions partially manned by watchkeepers. Watch kept in H.Q.1 from which W.T. openings are controlled. Water-tight patrols active.
IV	Attack unlikely without adequate warning ; <i>e.g.</i> in a defended harbour.	XY	W.T. conditions relaxed as much as possible for maintenance of machinery and equipment and comfort of the crew. Watch kept in H.Q.1, or in H.Q.2. if more convenient, and W.T. openings controlled from there. In small ships the W.T. openings are controlled by the O.O.W. or O.O.D.
V	Normal peace routine.	X	W.T. conditions relaxed except for the control of certain X and Y openings of vital importance to the general safety of the ship. W.T. openings may be controlled by O.O.W. if no watch is kept in H. Q. 1 or H. Q. 2.

- (i) *Condition Z* is the highest condition of water-tightness, and is always assumed when at action stations and when other similar emergencies arise. In this condition all X, Y and Z openings, except those specifically exempted, are completely closed.
- (ii) *Condition XY* is the normal war-time condition, during which the opening and closing of X and Y openings are directly controlled either by the H.Q.1 or the O.O.W. The degree of control exercised (*i.e.* the number of openings allowed to be opened, or left open, at any time) will depend on the prevailing circumstances.
- (iii) *Condition X* is the normal peace-time condition, during which the opening and closing of only X openings and certain Y openings with red markings are controlled. In fog, or at night, or when entering or leaving harbour, or when manœuvring, the XY condition would be assumed in peace-time.

ORDERS FOR ASSUMING THESE CONDITIONS

To avoid any possibility of confusion between the words "close" and "open" the latter is never used when ordering a change from one water-tight condition to another. The word "close" is used always when ordering a change from a lower to a higher condition, and the word "resume" is used always when ordering a change from a higher to a lower condition. The following examples show how the changes are ordered :—

condition Z is assumed on the order "Close Z openings" ;

condition XY is assumed from condition Z on the order "Resume condition XY", and from condition X on the order "Close X and Y openings" ;

condition X is assumed from condition XY, or Z, on the order "Resume condition X".

To close all water-tight openings in an emergency the order is given "D'y'e hear there! Close red and blue openings". This order automatically cancels any permission which may have been given for an opening to be opened. When the danger is past, the emergency condition is cancelled by the order "Resume condition XY (or X)".

W.T. Board and Integrity Log

The state of the water-tight doors and hatches throughout the ship can be ascertained at any time from the "Water-tight Door and Hatch Board". On this board is drawn a plan of each of the ship's decks, and in each plan there is a hole to mark the position of each water-tight door and hatch. In the higher states of readiness this board is kept by the H.Q.1, and in State IV by the O.O.W. Whenever permission is granted to open a door or a hatch a peg is inserted in the appropriate hole. The Control Officer can see by glancing at this board which doors or hatches are open, and so can immediately decide whether to give or refuse permission to open any others.

Whenever permission is granted to open a water-tight opening, this fact, together with such details as the name of the person to whom permission was given and the time of opening, is recorded in the "*Water-tight Integrity Log*" (S.326). When the opening is reported closed again, this report, with its time, is recorded against the original entry.

Identification Markings

Main Compartments.—In Chapter II of this volume it was stated that decks were numbered consecutively from the highest to the lowest, and that sections between main transverse bulkheads were lettered consecutively from the bows aft, omitting the letters I and O. A main compartment which lies between two main transverse bulkheads and extends from side to side of the ship is therefore known by a large figure and a large capital letter; the main compartment "4N", for example, would lie on No. 4 deck and in N section.

A compartment which extends between two or more decks, a boiler-room for example, bears the number of the deck on which it stands and the letter of its section.

Sub-Compartments. If the main compartment is sub-divided into smaller compartments each will be designated by the marking of its main compartment, and also by a smaller capital letter and a smaller figure which will denote the position of the sub-compartment within the main compartment. The manner in which these sub-compartments are marked is described below and illustrated in Figs. 290 and 291.

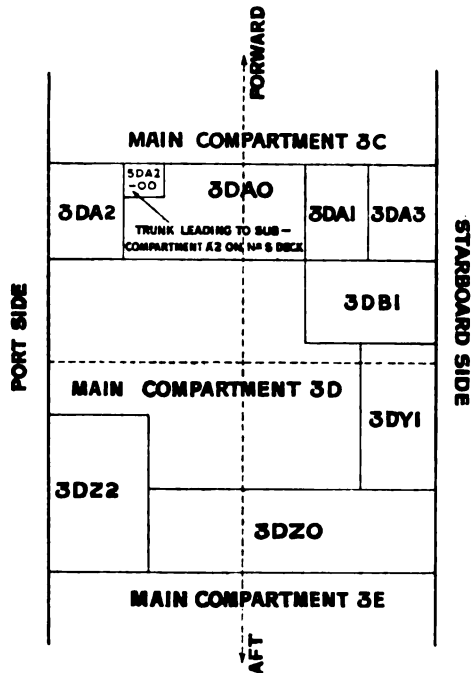


Fig. 290. Identification markings of sub-compartments

All sub-compartments lying before the athwartships centre-line of the main compartment are lettered A, B, C, etc., from forward aft, according to their respective positions abaft the forward bulkhead of the main compartment, and all sub-compartments lying abaft the athwartships centre-line are lettered Z, X, Y, etc., from aft forward, according to their respective positions before the after bulkhead of the main compartment.

All sub-compartments lying on the fore-and-aft centre-line are numbered zero ; those lying to starboard are numbered 1, 3, 5, etc., and those lying to port are numbered 2, 4, 6, etc., according to the position of the sub-compartment in relation to the centre-line.

An access trunk which extends between two or more decks is given the marking of the lower compartment to which it gives access, followed by the figures 00.

Doors, Hatches, and Manholes.—In general doors bear the marking of the compartment into which they open or give access. A door in a main athwartships bulkhead is marked with the deck number and the letters of the sections each side of the bulkhead ; a door marked " 3 D/E ", for example, would be in the main bulkhead separating compartments 3D and 3E.

A hatch is marked with the number of the deck in which it is cut, the letter of its section, and the subsidiary letter and number of the compartment to which it gives access ; a hatch marked " 2 D A 1 " would be in No. 2 deck, section D, and would give access to compartment 3 D A 1.

A manhole in a hatch bears no marking ; other manholes bear the marking of the compartment or tank to which they give access.

Ventilation Valves and Seacocks.—A ventilation valve is marked by a serial number (an odd number if on the starboard side of the fore-and-aft midship line and even if on its port side) followed by the marking of the compartment in which it is situated.

A seacock and its controlling handwheels are marked by the number of the deck and the letter of the section in which the seacock is fitted. If two seacocks are in the same section they are distinguished from each other by the words " port ", " starboard ", " forward ", or " aft " as necessary.

MISCELLANEOUS MARKINGS ON BULKHEADS

A bulkhead of a compartment may, in addition to its number and the identification marking of the compartment, be marked with a " contents circle ", within which are indicated the number of water-tight fittings within that compartment. If there is an arrow on the contents circle it indicates the number of water-tight fittings within the sub-compartment towards which the arrow points.

Some bulkheads may be marked with an " other side " marking, consisting of the letters " O.S. " followed by the name of a compartment. Such a marking indicates the nature of the compartment on the other side of the bulkhead ; " O.S.-6. in MAG.", for example, would indicate that the 6-inch magazine is on the other side of that bulkhead.

Bulkheads of main and sub-compartments near the waterline may be marked with a line and the letters L.W.L. to indicate the height of the load-waterline. This marking is important when adjacent compartments have been damaged and are flooded and open to the sea.

In addition to these markings bulkheads may be marked by arrows to indicate the main traffic route along a deck. The position of " Casualty stations " (C.S.) and " First-aid posts " (F.A.P.) may be indicated on bulkheads by red crosses with the letters C.S. or F.A.P., and a red arrow where necessary. The identification markings of electrical fittings are always in green.

Equipment

The equipment provided for damage control can be separately classified as for "fire", "flooding", "general damage", and "electrical repair", of which fire-fighting equipment is dealt with in Chapter III. All this equipment is stowed in fixed stowages throughout the ship, and the selection of the sites for each stowage is governed by the following requirements:—

- (i) each section should, as far as possible, be provided with a complete set of equipment ;
- (ii) the equipment should be handy to the area where it will most likely be needed ;
- (iii) spare gear should not be placed near the gear it is designed to replace.

FLOODING EQUIPMENT

This can be further classified as "leak-stopping" and "pumping" equipment.

Leak-stopping equipment includes the following :—

Soft-wood Plugs, which are tapered and of various sizes and used for driving into small, clean-cut holes in the ship's side, such as may be made by small shells.

Stopper Plates, which are square steel plates, measuring 8 in. × 8 in. or 14 in. × 14 in., and are fitted with a screwed bolt and batten, and a bolster pad around the edge of the outside face. They are clamped over holes in the ship's side by means of the bolt and batten.

Splinter Boxes, which are made of steel, vary in size from 12 in. × 12 in. × 5 in. to 18 in. × 18 in. × 6 in., and are clamped over jagged splinter holes in the ship's side.

Leak-stopping Mats, 4-ft. square, with thrumbs on one side and plain canvas on the other. They may be stuffed into a hole as a temporary measure, or be laid over the hole with the thrumbs next to the plating and then be backed up by a shored board or plate.

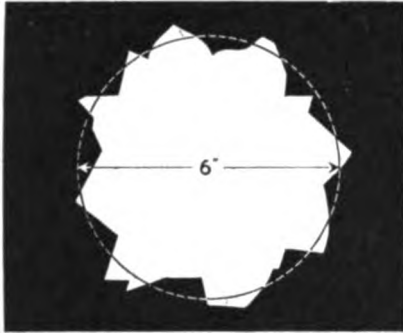
Bolster Patches, which are long bolster-shaped rolls of canvas, stuffed with oakum, and designed to pack the edges of jagged holes.

Cox's Bolt-gun, a portable gun which can fire a steel bolt into, or through plating. It can be used for riveting or for clamping plates over holes in the ship's side.

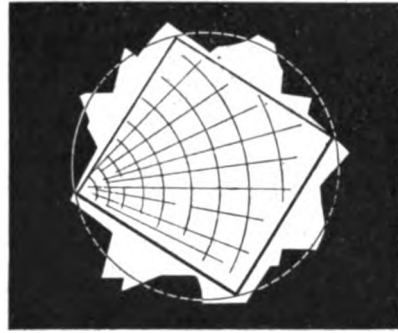
Pumping Equipment.—If a flooded compartment cannot be pumped out by any of the ship's pumping systems, such as the main-suction or fire-and-bilge pumps, it can be pumped out by the portable pumps provided. There are two types of portable pump, one electrically-driven and the other diesel-driven ; the former weighs 400 lb. and the latter 600 lb. ; each has a capacity of 70 tons per hour with a maximum lift of 24 feet, neither is water-tight and they cannot therefore be used under-water.

It is useless to attempt to pump out a compartment into which water is flowing at a rate faster than can be dealt with by the available pumps. The rate of inflow of water through a hole in a ship's side depends upon the area of the hole and its depth below the waterline. Even if the leak cannot be completely stopped it may be possible to plug the hole sufficiently to reduce the inflow of water to within the capacity of the available pumps ; and the leak can be effectively stopped when the level of the water falls below it.

The table below shows, for different depths, the rate of inflow of water in tons per hour through an unplugged, and a partially-plugged, hole of 6 inches diameter, and also the number of 70-ton pumps required to overcome the flooding at each of these depths.



UNPLUGGED HOLE



SAME HOLE PARTLY PLUGGED

DEPTH BELOW W. L. IN FEET	TONS PER HOUR	NO OF 70 TON PUMPS
2	228.2	4
4	323.2	5
9	484.8	7
16	646.4	10
25	808.2	12

DEPTH BELOW W. L. IN FEET	TONS PER HOUR	NO OF 70 TON PUMPS
2	62.6	2
4	117.4	2
9	176.2	3
16	235	4
25	293	5

Fig. 292. Effect of plugging a shell-hole

Note.—The amount of water varies directly with the area of the hole and the square-root of its depth below water level.

Although the suction lift of the pumps is limited to 24 feet, they are capable of discharging water to a height of 30 feet.

EQUIPMENT FOR GENERAL DAMAGE

Small stores and tools, and the smaller leak stopping devices required for general damage, are also stowed in special lockers in various parts of the ship. In addition, shores for supporting decks, bulkheads and the ship's side are stowed between decks and on the upper deck.

EQUIPMENT FOR ELECTRICAL REPAIRS

This includes spare machinery, spare parts, tools and a variety of small stores which also are stowed in special lockers throughout the ship.

MAINTENANCE AND INSPECTION OF EQUIPMENT

A routine should be laid down for the regular inspection of all damage control equipment. The period between inspections will vary with the nature of the equipment. The objects of these inspections are to :—

- (i) ensure that no equipment is missing ;
- (ii) ensure that each item is correctly stowed ;
- (iii) ensure that each item, and hence the system to which it belongs, functions correctly ;

- (iv) prevent deterioration from rust, damp or other causes ;
- (v) ensure the replacement of defective equipment.

Items of equipment included in such inspections are : all fire-fighting appliances ; the clips and rubbers of all water-tight doors, hatches and scuttles ; ventilating systems and their sluice valves ; scuppers and drains and their valves ; magazine and hangar spray systems ; all rescue and life-saving equipment, and their stowages and slipping devices ; all personal equipment such as anti-gas respirators, life-jackets, and anti-flash gear.

Water-tight Tests

Doors, hatches and scuttles should be tested periodically for water-tightness. A simple way of carrying out this test is to chalk the bearing edge of the fitting and then close it and clip it down ; then open it and, if water-tight, the rubber sealing strip will show an even and continuous chalk line round its bearing surface. If the chalk line is not even or continuous the fitting will not be water-tight and should be reseated.

A compartment can be tested for water-tightness by a "light test", an "air-suction test", or an "air-pressure test".

For the light test the compartment is closed, and all adjacent compartments (above, below and at the sides) are illuminated as brilliantly as possible, so that from within the compartment the light from outside will be seen shining through any unplugged holes or badly fitted joints.

For the air-suction test a partial vacuum is created in the compartment by an exhaust fan, and leaks can then be found from inside the compartment under test. For this test the compartment should be shut down and its exhaust fans started, and if the compartment is water-tight the fans will create a good vacuum in it ; this is easier than the air-pressure test because the latter entails the inspection of adjacent compartments.

For the air-pressure test the compartment is closed, and then air is forced into it under pressure through the air-test plugs in the door or hatch. Failure of the compartment to maintain the pressure shows that it is not water-tight.

Marking of Pipes

The different pipe systems of a ship are marked with distinctive colours so that they may easily be identified.

The piping of the firemain, hangar spray, and main-suction systems is marked with one colour throughout. Other systems are coloured only on the connecting flanges of the joints in the piping and on about two feet of pipe each side of the flanges. In these latter systems the colour of the pipe indicates the type of the system, and the colour on the flange differentiates between two systems of similar type. For example, the cold fresh water system is marked in blue on the pipes and the flanges, whereas the hot fresh water systems are marked in blue on the pipes and in pink on the flanges. The colours of the principal systems are shown in the following table.

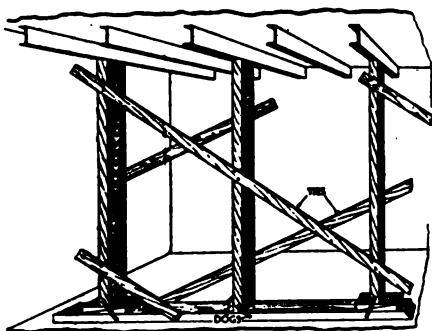
<i>System</i>	<i>Colour marking on pipes</i>
Firemain and hangar spray	Red
Main-suction	Yellow
Salt-water services	Green
Fresh-water services	Blue
Compressed air	Stone
Oil fuel, diesel oil and lubricating oil	Brown
Petrol	Orange

Shoring

Shores are used for : reinforcing or supporting decks ; preventing them from buckling upwards from pressure below ; reinforcing damaged or straining bulkheads, doors or hatches ; keeping doors and hatches water-tight against an inflow of water ; holding leak-stopping gear in place ; and for supporting damaged and weakened structures and fittings.

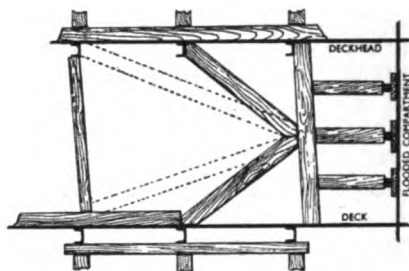
Shores should always be placed and fitted so that their anchorages will be secure, and the support they afford distributed evenly over as large an area as possible. Various methods of shoring are illustrated in Fig. 293 ; the choice of method must depend upon the purpose for which the shores are used, the materials available, and the extent of the structure to be shored, but the following general principles should be observed in all shoring :—

- (i) The length of a shore should be not more than thirty times its mean diameter. For example, a 3 in. $\times$ 3 in. shore should not be longer than 90 inches.
- (ii) Shores should not be cut to the required length beforehand, because a ready cut shore would probably not fit a damaged structure.
- (iii) Bulkheads and decks should not be shored in anticipation of damage, because the shores would then transmit the shock of an explosion to structures which might otherwise have remained unharmed.
- (iv) Shores should be cut to fit as accurately as possible so as to reduce the use of wedges to a minimum ; a "proud shore", *i.e.* one which is slightly longer than the space in which it is to be fitted, is useful in this respect.
- (v) Where wedges are necessary they should be used in pairs and driven against each other from opposite sides ; they should either be hammered home simultaneously, or a heavy weight should be held against one while the other is driven in. Wedges which are covered with oil should be coated with sand or soaked in water before use, and sand should be scattered over any oil-covered surfaces against which shores or wedges will have to be driven.
- (vi) Staples or iron clamps ("dogs") should be used for tying shores to their head and sole-pieces or pad-pieces, also for tying breast shores to upright shores.
- (vii) If sufficient material for shores is not available, thick deals or mess stools, bolted together, will make effective shores.
- (viii) For large compartments such as boiler and engine rooms, fabricated shores consisting of short lengths bolted together may have to be used.



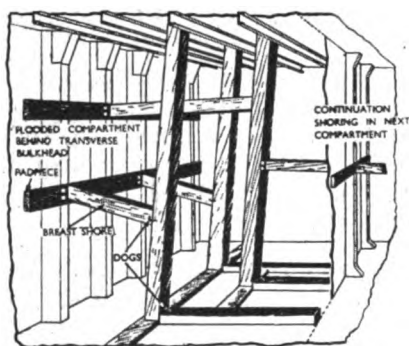
DECK PADPIECE - 7' x 3' OR 12' x 2'

SHORING A DECK



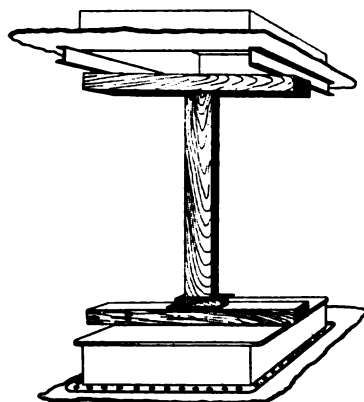
BULKHEAD, UPRIGHT, AND 'V' SHORES - 6' x 6'
DECKHEAD PADPIECE - 7' x 7'

SQUARE AND 'V' SHORING

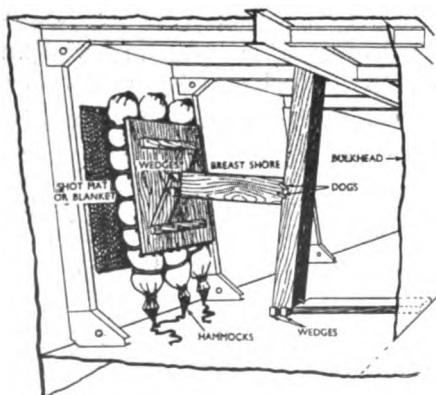


UPRIGHT SHORES 6' x 6', BREAST SHORES 4' x 4'
PADPIECES 7' x 3' OR 12' x 2'

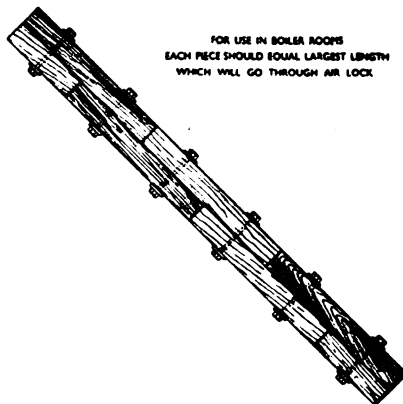
SQUARE SHORING



SHORING A HATCH



BREAST SHORE - 7' x 3' OR 6' x 4'
STOPPING HOLE IN SHIP'S SIDE



PRE-FABRICATED SHORE
MADE OUTSIDE BOILER ROOM AND ASSEMBLED INSIDE

Fig. 293. Methods of shoring

(ix) Shoring must be continually watched to ensure that the shores and wedges do not work out of place.

Bulkheads.—The first and most effective shore for a bulkhead which is straining but still intact should be set up on a pad-piece against the bulkhead, at one-third its height and at the centre of its width. Where a number of shores are used to support one pad-piece they should be cross-tied, otherwise panting caused by the straining of the bulkhead will loosen the shores and they will fall out of position.

Decks.—Decks are best supported with shores set up vertically between long pad-pieces running fore and aft along the deck and deckhead.

Hatches.—A quick method of securing a hatch is shown in Fig. 293. When time allows it is better to set up a number of vertical shores round the rim of the coaming so as to distribute the pressure evenly round it.

Water-tight Doors.—As a first emergency measure to reinforce a straining door, a vertical pad-piece should be placed just clear of the clips along the side opposite to the hinges, and this should be held in place by a single shore placed with its heel against a stout part of the ship's structure or an upright shore. When time allows, the door should then be reinforced by another pad-piece set up along its hinged side.

The reverse side of a straining door should be reinforced by a vertical pad-piece set up against its middle-line.

Door or hatch shoring should not be set up harder than is necessary to hold it firmly in place. If set up too hard the fittings may become distorted and leaking thus aggravated.

ELEMENTARY SHIP STABILITY

A seaman should know the elementary principles of ship stability to enable him to load his vessel with cargo or passengers without endangering her seaworthiness. Such knowledge will also enable him to take the best measures for ensuring the safety of his vessel should her seaworthiness be endangered through the effects of collision, storm, or enemy action. The elementary principles governing the buoyancy and stability of a ship are therefore described in this section.

Flotation

A flat sheet of metal placed in a tank of water will sink to the bottom, and the volume of water which it displaces will be equal to the volume of the sheet

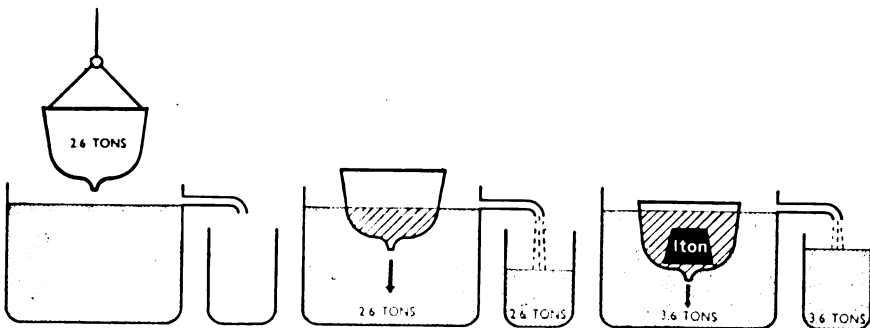


Fig. 294. Flotation and displacement

of metal. If, however, the sheet of metal is moulded into the form of a water-tight box it will float on the surface of the water, and the volume of water then displaced will be equal to the volume of the immersed part of the box, and its weight will be equal to the weight of the box.

These facts are illustrated in Fig. 294, which represents a boat weighing 2.6 tons lowered into a tank of water. When the boat is water-borne, 2.6 tons of water are displaced, the volume of which is equal to the immersed volume (shown shaded) of the boat. If a weight of one ton is placed in the boat she will sink down into the water until 3.6 tons of water are displaced, and the volume of water displaced will be equal to the volume (shown shaded) of the immersed part of the boat.

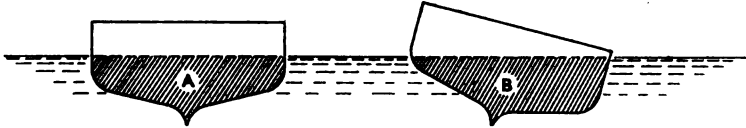


Fig. 294.

If the boat heels to one side the shape of the immersed portion of her hull will alter, but the volume will remain the same. In Fig. 295 the volume of the shaded portion A equals that of the shaded portion B, and the weight of water displaced by the volume of A equals the weight of water displaced by that of B.

Buoyant Volume

The buoyant volume of a ship is the volume of the entire water-tight part of the hull. That portion of the buoyant volume below the waterline is called her "buoyancy", and that portion above the waterline is called her "reserve of buoyancy".

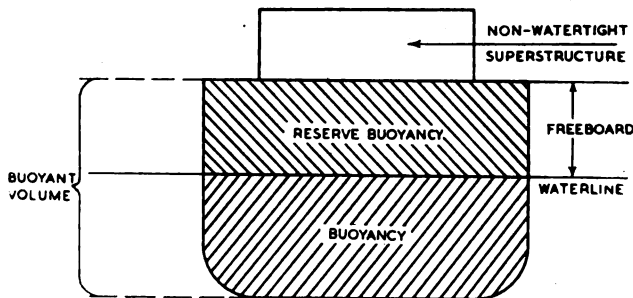


Fig. 296. Buoyant volume

The "freeboard" is the height above the waterline at the ship's side of the highest continuous water-tight deck. As most ships are nearly wall-sided (*i.e.* perpendicular) above the waterline the freeboard gives an approximate measure of the reserve of buoyancy.

Centres of Gravity and Buoyancy

A ship's ability to float depends upon two factors, her weight and her buoyancy.

By her weight is meant the sum of the weights of everything in the ship, including that of all the structure, machinery, armament, fittings, stores, fuel, crew, cargo and passengers, and its effect can be visualised as exerting a single force through a central point which is called the "centre of gravity" (usually indicated by the letter G, see Fig. 297).

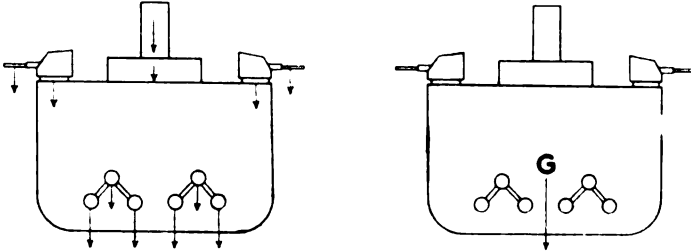


Fig. 297. Centre of gravity

By her buoyancy is meant the upward force exerted on the ship's hull by the water when she is floating, and it is equal to the weight of water she displaces. Although this force is distributed over all the underwater surface of the ship's hull it also can be resolved into a single force exerted through a central point which is called the "centre of buoyancy" (usually indicated by the letter B, see Fig. 298).

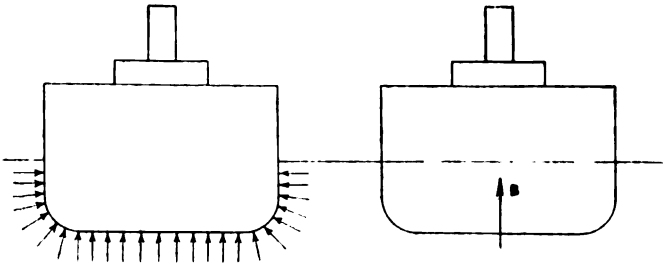


Fig. 298. Centre of buoyancy

As each longitudinal half of a ship's hull is symmetrical, B is on the middle-line when the ship is floating upright; and as the weights must then be distributed symmetrically, G is also on the middle-line.

Conditions for Equilibrium

For a ship to float in equilibrium the buoyancy force pushing upward on the underwater part of the hull must be equal to the total weight of the ship, and as these two forces balance one another they must be acting in the same straight line (see Fig. 299(a)).

When two equal and opposite forces acting on the same object are not in line they produce a moment tending to rotate the object; this moment is calculated by multiplying the distance between the points at which the two forces act by the force of one of them.

If a ship is heeled over by some external force, the weight, and hence the position of the centre of gravity, will remain unaltered; but as the shape of the submerged part of the hull will be changed, the centre of buoyancy, B, will move from the middle-line towards the lower side of the ship, as shown in

Fig. 299(b) Here the forces of weight and buoyancy are out of line and therefore produce a moment tending to rotate the ship. If this moment tends to return the vessel to an upright position (as shown in Fig. 299(b)) she is said to be in "stable equilibrium".

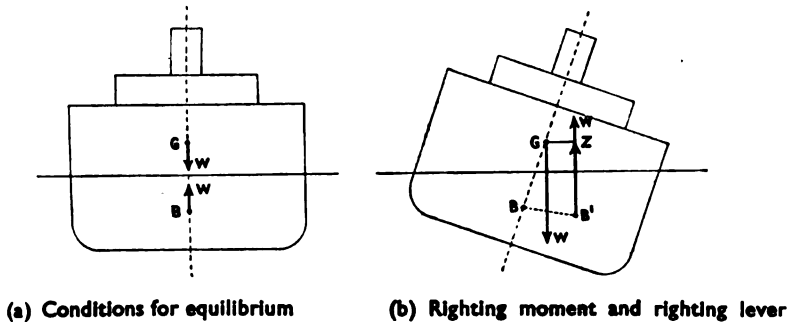


Fig. 299.

RIGHTING MOMENT AND RIGHTING LEVER

In Fig. 299(b) the "righting moment" acting on the ship is calculated by multiplying the displacement (W) by the horizontal distance between the resolved forces of weight and buoyancy (GZ).

The horizontal distance GZ , which separates the forces of weight and buoyancy as the ship heels, is called the "righting lever".

The degree of stability of a ship (*i.e.* her resistance to heeling forces) at any angle of heel is given by her righting moment. The degree of this righting moment depends upon the size and shape of the submerged part of the hull, which determines the position of B , and also on the distribution of the weights of stores, fuel, guns, cargo, machinery, etc., which determines the position of G .

As the weight and centre of gravity of a ship is unaltered (apart from small differences due to free liquids) as the vessel is heeled over by an external force, her stability can be measured solely by the length of the righting lever GZ .

Thus it will be seen that the stability of a ship is dependent upon these three facts :—

- (i) the shape of her hull (both of the portion normally underwater and the portion liable to be submerged as the ship rolls) will determine the position and movement of the centre of buoyancy ;
- (ii) the arrangement of weights such as engines, boilers, guns, cargo, etc., will determine the position of the centre of gravity ;
- (iii) the positions of the centres of gravity and buoyancy in relation to each other and to the ship will determine her degree of stability.

In designing a ship's hull a compromise must be reached between the requirements of speed, capacity and stability. Too much weight above the centre of gravity, due to superstructures, guns, radar equipment, derricks, and deck cargo for example, may raise the centre of gravity sufficiently to endanger her stability, thus making her top heavy. A ship whose beam is unduly narrow may not have a sufficiently large or powerful righting lever to enable her to recover from a heavy roll.

A warship must be designed with a sufficient margin of stability to keep her stable when damaged and partly flooded.

PERIOD OF ROLL

When a ship is rolling, the degree of the righting moment produced depends upon the severity of the roll, *i.e.* upon the angle of inclination of the ship from the vertical.

This righting moment ($B_1 \times GZ$ in Fig. 300) will oppose the roll away from the upright position and hasten the roll back to it, and its magnitude will depend upon the shape of the ship's hull and her degree of stability.

A ship with a large righting moment (*i.e.* good stability) will roll rapidly, with a lively motion. Conversely, a ship with a small righting moment (*i.e.* poor stability) will roll sluggishly. The period of a ship's rolling thus gives an indication of her stability.

A ship which is too lively will be uncomfortable ; her violent movements may even carry away her masts and other fittings, and, if a warship, she will not afford a sufficiently stable gun platform. If too sluggish, however, she will be unsafe in heavy weather, so a compromise in these respects has to be achieved by the designer.

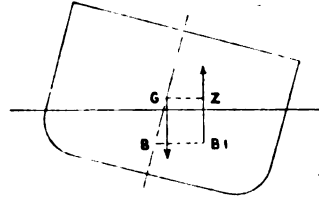


Fig. 300. Period of roll

Heel, List and Trim

Heel is a ship's athwartships inclination either side from the vertical, however caused ; a sailing vessel, for example may be heeled by the wind to her leeward side.

List is a heel caused by off-centre loading ; it will be permanent until artificially corrected.

Trim describes the inclination of a ship's designed horizontal fore-and-aft plane with the surface of the water in which she floats. When in normal trim the ship's fore-and-aft plane lies parallel with the surface of the water ; she may, however, be " trimmed (*i.e.* down) by the bows, or stern ".

Effects of Loading, List, Ballast, and Topweight

EFFECT OF LOADING A SHIP

The effect on her stability of adding a weight to a ship will depend on the size and position of the weight, but it will always result in the mean draught of the ship being increased and in her centre of gravity being moved towards the added weight. The latter effect can be illustrated by the simple example given in Figs. 301 and 302.

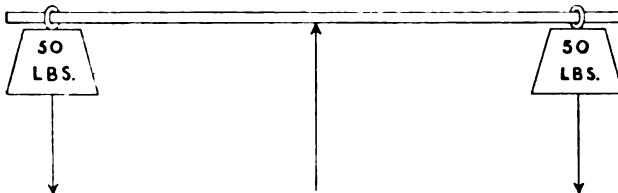


Fig. 301.

If two equal weights are hung equidistantly from the middle point of a metal bar it will balance about that point because that is the centre of gravity of the whole (Fig. 301).

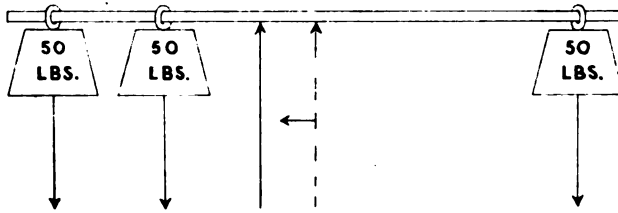


Fig. 302.

If another weight, however, is added on one side of the support (as shown in Fig. 302), the support will have to be moved from the middle towards the heavier end in order to preserve the balance of the whole. In other words, the centre of gravity of the whole has moved towards the added weight.

Off-centre Loading (Fig. 303).—When a heavy weight is added on either side of a ship, her centre of gravity moves towards that of the added weight, *i.e.* from G to G_1 in Fig. 303(a). The weight and buoyancy forces are no longer in the same straight line and so they produce a moment which will list the ship towards the side on which the weight was added. As the ship lists, so B moves towards the low side until it reaches position B_1 , vertically below G_1 , as shown in Fig. 303(b). Then, with the centres of buoyancy and gravity once more in the same vertical line, the ship will float in equilibrium in the inclined or listed position.

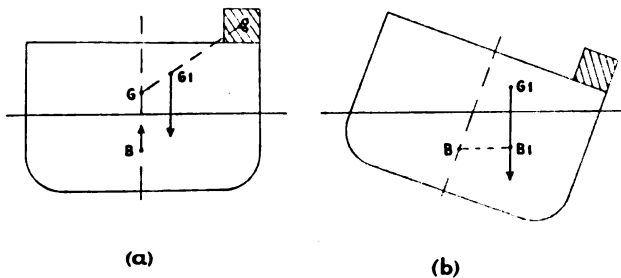


Fig. 303. Effect of off-centre loading

EFFECT OF LIST ON STABILITY

It may be said that the stability of a ship is reduced by a list because G has moved off the middle-line. Any further heel in the same direction as the list will produce a smaller righting lever than it would if G were still on the middle line; in Fig. 304, for example, $G_1 Z_1$ is less than GZ .

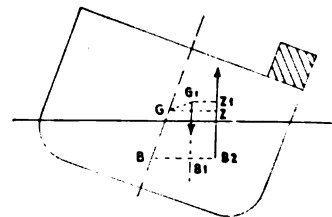


Fig. 304. Effect of list on stability

Righting levers will, however, be correspondingly increased if the ship is heeled away from the list.

BALLAST

If a weight is added low down on the middle line of a ship it will have the effect of lowering the centre of gravity, *e.g.* from G to G_1 in Fig. 305(a). This will improve her stability, because it increases the righting lever at any angle of heel. The righting lever after ballasting, $G_1 Z_1$ in Fig. 305(b), is greater than the original righting lever GZ .

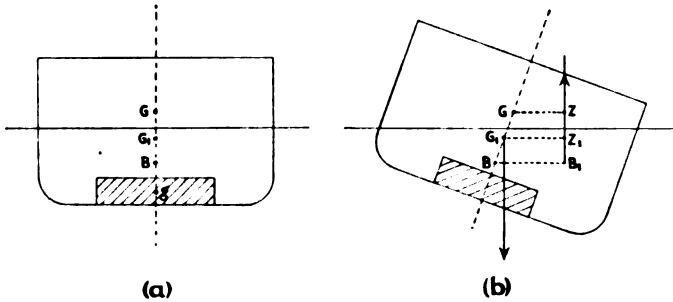


Fig. 305. Effect of ballast

TOP-WEIGHT

Conversely, a weight added high in the ship will raise the centre of gravity, *e.g.* from G to G_2 in Fig. 306(a), and the stability will then be reduced. In Fig. 306(b), for example, $G_2 Z_2$ is less than GZ . Additional top-weight is therefore dangerous and should be avoided as much as possible.

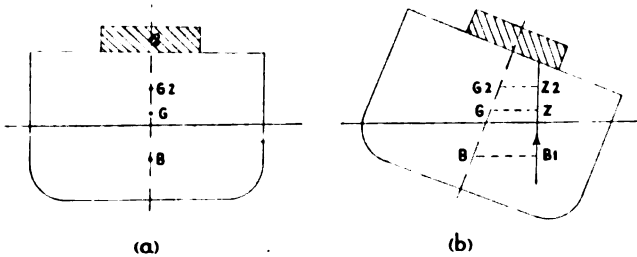


Fig. 306. Effect of topweight

Effects of Flooding, Free-surface Liquid, and Methods of Countering

Completely flooding a compartment will have exactly the same effect on the stability of a ship as adding a solid substance of equal weight at the centre of gravity of the flood-water. For example, completely filling a centre-line oil fuel tank would ballast the ship and so improve her stability.

FREE-SURFACE LIQUIDS

If an oil fuel or other tank is only partly filled, however, the liquid in it has what is called a "free-surface", being free to run across to the low side as the ship heels or rolls. This will have the effect of moving the centre of gravity of the ship towards the low side, thus reducing the righting lever, so that in the example shown in Fig. 307, $G_1 Z$ is less than GZ .

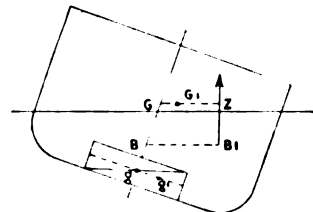


Fig. 307. Effect of free-surface liquid

Free-surface liquid therefore reduces stability. If free-surface liquid is added to compartments high up in the ship, during fire-fighting for example, it will have a more adverse effect on the ship's stability than if it were added low down, because this combines the bad effects of top-weight and free-surface.

SUBDIVISION OF FREE-SURFACE LIQUIDS

If the same tank were fitted with a middle-line bulkhead (see Fig. 308) the centre of gravity of the liquid in it will not move so far from the middle line when the ship heels or rolls, because the two smaller volumes of the liquid will move through shorter distances; the loss of righting lever and stability will therefore not then be so great.

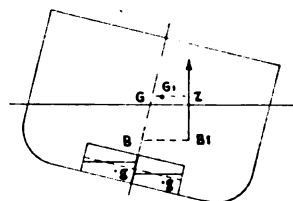


Fig. 308. Subdivision of free-surface liquid

For this reason longitudinal bulkheads are fitted in oil fuel and water tanks to break up the free-surface and so reduce its effect on the ship's stability.

Dwarf Bulkheads and Sills.—For the same reason longitudinal and transverse dwarf bulkheads, and sills in doorways, are built to a height of 2 ft. 3 in. on decks near the level of the waterline. Their main function is to prevent the spread of shallow flood-water over these decks and so reduce loss of stability due to the effect of free-surface.

Correction of List

Unless caused by damage, list is usually easy to correct. All that is required is to balance the ship and so bring the centre of gravity back to the middle-line. There are three ways of doing this:—

- (i) by removing the off-centre loading, or an equivalent weight on the low side;
- (ii) by adding an equivalent weight on the high side;
- (iii) by shifting weights from the low side to the high side.

For a damaged ship with off-centre flooding causing a list, method (i) is usually impracticable because flood-water cannot be removed from compartments which are open to the sea, and the weight of this water is so great that there is nothing of sufficient weight which can be removed from the low side to compensate it.

Method (ii) usually affords the quickest means of correcting list, because the equivalent weight can be added by counter-flooding wing compartments on the high side by admitting sea water to them. In big ships, valves are usually fitted low down in wing water-tight compartments so that they can be flooded direct from the sea.

Method (iii) is theoretically the best, because it avoids the increase of the ship's displacement produced by method (ii). In practice, however, it usually means transferring oil fuel or other liquids across the ship, which is a slow process and not suited to the rapid correction of list under action conditions.

Loll

The term "loll" describes the state of a ship which is unstable when in an upright position, and which may therefore heel to one side or the other and remain thus heeled until again moved by some external force such as that

caused by wind or waves. Loll is quite different from list, being caused by different circumstances and requiring different counter-measures to correct it, and it is therefore most important that the seaman should be able to distinguish between the two.

Loll may be caused either by a large amount of free-surface water inside the hull or by a large addition of top-weight ; the following example shows how it may be caused by free-surface water.

In the description of "free-surface" (see page 501 and Fig. 307) it was shown that an effect of free-surface liquid was to reduce the righting lever by shifting G towards Z . The greater the extent of flooding by free-surface water the further will G move away from the middle-line when the ship heels.

Consider a destroyer with three flooded main compartments extending right across the ship. If the ship heels to starboard for example, as shown in an exaggerated form in Fig. 309, the water in the flooded compartments will run across to starboard and shift G so far that it may well pass beyond B_1 to the position G_1 .

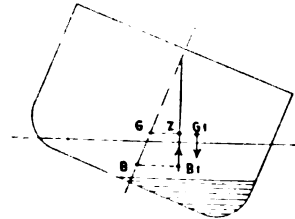


Fig. 309.

The centre of gravity G_1 of the flooded ship is now beyond the centre of buoyancy B_1 , and these two forces are tending to heel the ship still further over instead of returning her to the upright position.

As the ship heels over further, however, the centre of buoyancy will also move further to starboard and the ship will come to rest at an angle of heel at which the centres of gravity and buoyancy, G_1 and B_1 , are again in line, as shown in Fig. 310. The cross-sectional shape of the hull determines the extent to which the centre of buoyancy can move, and if G_1 is still beyond B when the latter has reached the limit of its travel the ship will capsize.

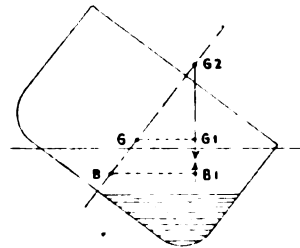


Fig. 310.

If, due to a change of course or to action by wind or waves, the ship heels over to port, the water in the flooded compartments will flow across the ship from starboard to port, and she will come to rest heeled to port at an angle equal to that of her previous heel to starboard (see Fig. 311).

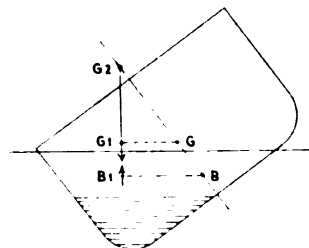


Fig. 311.

An exactly similar effect would be caused by an excessive amount of top-weight being placed in the ship, thereby raising the centre of gravity to a dangerous extent. This is illustrated in Figs. 310 and 311, in which G_2 represents the raised centre of gravity caused by top-weight. In this case the centre

of gravity is fixed and does not move from one side to the other with the heel of the ship, but the effect is the same as that caused by free-surface liquid.

In each case the ship is unstable, both when upright and when heeled to port or to starboard.

Reduction of Loll.—There are four methods of reducing loll :—

- (i) by reducing the amount of free-surface water ;
- (ii) by shifting weights from positions high in the ship to lower levels ;
- (iii) by adding weight low down in the ship ;
- (iv) by removing weights which are high up in the ship.

The choice of method or methods to be used depends upon the causes of the loll and the means available in the ship for correcting it.

The first method may be effected either by stopping or reducing the leaks causing the flooding and then pumping out the water, or by completely filling tanks low down in the ship which already contain liquids, and completely pumping out or draining any other tanks containing liquids.

The second method is usually impracticable because movable objects small enough to be lowered through hatches are not usually of sufficient weight appreciably to affect the centre of gravity, and even if they were sufficiently heavy they would then be difficult to shift, particularly if the ship was lolling to a large angle.

The third method may be effected by flooding compartments or tanks low down in the ship to their full capacity and thus ballasting the ship. It is effective in lowering the centre of gravity, but has the disadvantage of loading the ship still further and thereby reducing her reserve of buoyancy. If this method is employed it is important that the flooding should be carried out evenly each side of the middle-line of the ship to avoid introducing a list in addition to the existing loll.

The fourth method is probably the most practicable, especially in small ships, and produces a double improvement because it lightens the ship, and thus increases her reserve of buoyancy and lowers her centre of gravity. It is effected by jettisoning movable gear from the upper decks, but again care must be taken to do this evenly each side of the middle line and not to jettison equipment such as shores, fire-fighting equipment, and A.A. guns, which may be required later. Lists of suitable equipment should be prepared in the order in which they may be jettisoned so that this method may be effected quickly and correctly should the need ever arise.

Effect of List and Trim on Fighting Efficiency

Excessive list from any cause will reduce the fighting efficiency of the ship in a number of ways, of which the following are examples :—

- (i) It is difficult for men to get about the ship and carry out their duties properly when the ship is listed.
- (ii) List may restrict the fire of the ship's armament and decrease its accuracy by causing blind arcs of fire at angles of depression over the high side and increasing the effort required to train the directors, control-instruments, guns, rocket-projectors and torpedo-tubes. Six degrees is about the largest angle of list at which a ship's armament can be effectively fought.
- (iii) Speed and manœuvrability are reduced by list.

- (iv) The efficiency of some machinery, such as fixed pumps and feed regulators which depend for their operation on the maintenance of a steady liquid level, is reduced if the ship is listed heavily.
- (v) In aircraft carriers the aircraft cannot be operated if the ship is listed to more than about two degrees.
- (vi) When a ship is listed considerably the armour belt is submerged too much on one side and raised out of the water on the other, so that it no longer protects the waterplane area of the ship effectively.

Trim does not have any appreciable effect on fighting efficiency or stability unless it is so large that the freeboard at the low end is so little that the seaworthiness of the ship is endangered, or the forecastle or quarterdeck is under water.

CHAPTER XV

Ship Maintenance

PAINT AND PAINTING

THE primary object of paint is to provide steel, iron, wood and other substances with an air-tight and water-tight coating to prevent them from rusting, rotting or otherwise corroding ; it is only coloured for the sake of appearance. All paints are, however, to a certain extent porous, so several coats are necessary to make the coating fully protective.

Paint Coats and Paint Schemes

The first coat of paint applied is called the " priming coat ", and the paint used first is called a " primer " ; the last coat is called the " finishing coat ", and any intermediate coat is called an " undercoat ". A different type of paint is used for each coat, and each coat may consist of one or more layers of paint.

A primer has special properties of adhering to a new surface and of checking any corrosive tendencies which may be inherent in the material ; it also provides a mat (*i.e.* non-glossy) surface so that the undercoat or finishing coat will easily adhere to it, but because it is porous it will not provide a weather-proof covering. Examples of primers are red lead, red oxide, red zinc chromate, and aluminium paint.

An undercoat of " flatting " must always be used for woodwork if the finishing coat is to be enamel. Flatting is a quick-drying, porous paint, which provides a better surface for enamel than a primer and gives " depth " to it. Flatting only is used for interior surfaces, such as deckheads, which are covered with granulated cork, because being porous it allows the cork to absorb any surface moisture.

The finishing coat must be as non-porous as possible, and provide a hard, smooth water-tight surface so that it will not absorb moisture and will withstand weather and wear. Most paints used as a finishing coat must be applied on a mat surface as otherwise they will not adhere to it ; they usually dry with a glossy or semi-glossy finish, examples being enamels, oil paints, and synthetic-resin paints.

Different materials may require different types of coats and different methods of application ; steel and wood, for example, require different primers. Again, the coating required in one part of a ship may be very different to that required for the same material in another part ; the paints used on a ship's bottom and sides, for example, are very different. The required types of paint, number of coats, and method of applying them are together known as a " paint scheme ", and the schemes required for weatherwork (*e.g.* the superstructure and ship's side), underwater surfaces, and the various interior surfaces of the ship, differ from one another and are prescribed from time to time in *Admiralty Fleet Orders*.

Composition of Paint

The main ingredients of a paint are the " pigment " and the " vehicle ". The pigment, in the form of a fine powder or a paste, provides the body and

colour of the paint and consists of such substances as white lead, red lead, zinc oxide, or aluminium. The vehicle is the liquid or solvent with which the pigment is mixed so that it can be applied to a surface as paint, and it consists of liquids such as linseed oil, or a varnish made by dissolving resins in linseed oil.

Other ingredients may be mixed into a paint to give it special qualities or a certain colour; the chief of these are "driers", which is a spirituous liquid or paste added to make the paint dry quickly, and "thinners", which is a liquid such as white spirit or naphtha which may be added to make the paint thinner.

Types of Paint

Enamels provide a very hard and glossy surface which is impervious to water and very durable, but liable to crack from maltreatment or exposure to intense heat or cold. Being expensive they are used sparingly on weatherwork and interior decoration, and as they are very inflammable, both in liquid form and after application, they are not used in the Royal Navy.

Varnishes consist mainly of resin dissolved in some form of spirit. They are very quick-drying and provide a very hard and glossy surface on woodwork, but they also are expensive and highly inflammable and are therefore not used in the Royal Navy.

Oil Paints are those whose vehicle is an oil, such as linseed oil or cotton-seed oil, and so are not particularly quick-drying but make a good glossy or semi-glossy finishing coat. As oil paints are cheaper and not so highly inflammable as enamels and varnishes they are used generally as coatings for weatherwork and interior work, but being inflammable they have been superseded in the Royal Navy by synthetic-resin paints which provide a fire-resistant coating.

Lead paints, both primers and finishing paints, are those whose pigments contain lead in some such form as red or white lead. Their use for confined spaces such as double bottoms is prohibited because they may cause lead poisoning.

Cellulose paints, sometimes called "dope", are very quick-drying and used chiefly on aircraft. Their vehicle is usually a form of naphtha which gives off noxious fumes, and they should therefore only be applied in specially ventilated compartments and the painter should wear some form of respirator. The ill-effects from lead or cellulose paints may to some extent be alleviated by eating bread and butter, eggs and milk.

Synthetic-resin paints are composed of a special pigment dissolved in a vehicle containing synthetic resin. They provide a good, durable finishing coat, with a mat or semi-glossy surface, and though inflammable in liquid form they are fire-resisting when applied as a coating. They are generally used in the Royal Navy for weatherwork and interior work.

Water-paints or distempers are not inflammable and have a vehicle of water or an oil emulsion. They provide a mat surface, and though not so durable as other paints they are not so liable to crack or peel off a surface which expands or contracts or alters its shape; they are therefore used for painting the lagging of steam pipes, the blast bags of guns, and the interior lagging of the ship's sides and deckheads.

Outer-bottom compositions are paints of a special nature which are designed to give a protective coating to the underwater surfaces of the hull. They are

of two quite different types, known as "protective" and "anti-fouling" compositions.

The protective composition is applied first, in two or more coats, and protects the steel against the corrosive action of salt and other impurities in the water. The type now used (1949) in the Royal Navy is called "Admar" and is supplied in three colours, namely red, black and chocolate, to enable one coat to be distinguished from another as it is applied.

The anti-fouling composition is applied over the protective composition, in two or more coats, and contains chemicals which slowly dissolve or "leech out" during the life of the paint and are poisonous to marine growths such as weed, and to marine parasites such as barnacles. The type now used (1949) in the Royal Navy is a plastic paint called "Pocoptic", and is supplied in two colours, red and black.

In addition to Admar and Pocoptic there are many proprietary brands of protective and anti-fouling compositions, but these are only used in the Royal Navy if Admar and Pocoptic are not available. If Pocoptic is not available a non-mercurial composition should be used over Admar.

The bottoms of wooden ships are usually sheathed with copper instead of being painted, because the copper fulfils the purposes of both the protective and the anti-fouling compositions. The bottom of a wooden ship which is not sheathed in copper should be painted with two or three coats of "copper anti-fouling composition", or with Pocoptic; Admar should not be applied to wood.

Mixing Paint

Paint is usually supplied to ships ready mixed in 1-gallon or 2-gallon tins, or in 5-gallon drums. After standing a while paint tends to separate into layers of its constituent ingredients, and it should therefore always be thoroughly mixed by stirring before use; the cause of many complaints on the quality of paint is due to insufficient mixing.

To open a tin or a drum the lid should be prised off carefully with a flat-ended tool so as not to damage it and placed aside for further use, inner side upwards. Any skin which may have formed on the paint should be removed and discarded, and the paint should then be mixed in either of the ways described below, the choice depending upon the size of the container.

- (i) If in a drum the paint should be stirred with a clean and stout batten of wood or steel, or with a paddle, using it with a circular, crosswise and up and down motion; this stirring should be very thorough to ensure that the paint is properly mixed, when it will be of a perfectly smooth and creamy consistency. Stirring a 5-gallon drum may well take an hour, and in cold weather even longer.
- (ii) If in a tin the top two-thirds of the paint should be poured into a clean empty tin, and the pigment and vehicle of the remaining third should then be stirred until the paint is of a smooth creamy consistency; to this should now be gradually added the contents of the second tin, while stirring it continuously; finally the paint should be poured to and fro between the two tins until it is uniformly smooth.

When mixing has been completed the paint should be strained through clean wire gauze, cheese cloth, or old but clean bunting.

If paint is allowed to stand for long in an open container a skin will form on the top of the paint and this must be removed before the paint is used. To

avoid wastage, therefore, paint should be used as soon as possible after mixing and should not be prepared in larger quantities than are actually required for the work in hand. Surplus paint should be poured into clean tins or drums, which should be carefully sealed and labelled with their contents, and then set aside for use at the first opportunity. After use, paint pots should be thoroughly cleaned with solvent, and, if necessary, burned out.

There is no exact formula for estimating the amount of paint required for any painting work ; so much depends upon the skill of the painters, the type and quality of the paint, and the temperature (paint will not go so far in cold weather as in warm weather), but usually one pound of paint should cover an area of between 4 and 7 square yards, and one gallon should cover from 60 to 80 square yards.

Preparation of a Surface for Painting

The preparation of a surface for painting is of the utmost importance ; *it must be clean and dry*, and so all rust, scale, loose paint, oil, grease, moisture, salt deposits and any other corrosive agents must be removed before the paint is applied. Failure to clean and dry the surface thoroughly will result in a coating which will crack, peel off, or blister, and under which corrosion will then spread unnoticed. The best paint applied on a moist, dirty, or unprepared surface will have a much shorter life than an inferior quality paint applied to a dry, clean and well prepared surface ; moisture and dirt also retard the drying of the paint and mar its finished appearance. The priming coat should always be applied as soon as possible after the surface has been prepared.

To prepare a steel surface for its first coat of paint it should be scaled (*i.e.* tapped to remove loose flakes of rust and scale) with a scaling hammer, then brushed with a wire brush until all rust is removed, and finally wiped or dusted dry. A power-driven scaling hammer should be used with care to avoid chipping or denting the steel and thus making a pitted and uneven surface for the paint.

To prepare a painted steel surface for re-coating.—There is no need to remove paint which is obviously in good condition unless its thickness is excessive ; such surfaces should be rubbed down with pumice stone and then washed and dried. Any surface which shows cracks, blisters, rust stains, discoloration, or thin or bare patches, must be removed completely. The old paint is removed by loosening it with blows from a flat-faced hammer, then scraping with a scraper, and finally brushing the whole surface with a wire brush until all paint and rust are removed. If there is any oil or grease on the surface it should be wiped over with a cloth soaked in white spirit or naphtha, and then be washed with fresh water and wiped dry with clean rags. Any salt on the surface should be washed off with fresh water.

To prepare a wood surface for its first coat of paint.—All knots and sappy places should be given a coating of “ knotting ”, a preparation which seals the sap in the wood and prevents it from exuding later and so raising, cracking, or discolouring the paint. If the wood is particularly sappy it should be warmed carefully with a blow lamp and the exuding resin be removed with a scraper.

To prepare a painted wood surface.—Sound paint is washed, then sandpapered to provide a mat surface, and finally wiped over with a clean dry rag. Old, unsound paint is removed with a sharp scraper, care being taken to work

with the grain of the wood, and the bare surface is then sand-papered and wiped clean. If the paint proves difficult to remove it can be softened, either with a blow-lamp or a liquid "paint-remover", and then be removed while still soft with a scraper; the surface should then be washed with fresh water to remove all traces of the paint-remover. It should be borne in mind that the blow-lamp or paint-remover is used to soften the paint, and not to burn or destroy it. The paint-remover should be applied with an old brush, and for particularly hard or thick paint several applications may be necessary. It must be remembered that many paint-removers are very inflammable; in the Royal Navy, however, only non-inflammable types are issued for sea service.

Painting generally

Paint is applied either with a brush or with a spray-gun; when both are available the spray-gun is used for large areas and the brush for small areas or for any intricate work. It is essential that both should be used correctly, as described later in this chapter, because if wrongly applied the paint will not be effective in providing a protective surface.

To be effective paint should not be applied in frosty or damp weather, and in cold weather it will "work" better if warmed before application.

Cordage and rubber should never be painted because paint rots them. The following materials and fittings should also not be painted, because paint either rots them or prevents them from functioning effectively:—

wire rope; running rigging, and working parts of rigging such as rigging screws; joints in rod-gearing, and sheaves of blocks; the working surfaces of bollards, fairleads, capstan-drums, cleats and staghorns; aerials and insulators; tallies; polished metal fittings; corticene; glass, leather, and similar materials; sails and awnings; wood fittings such as hand-rails; polished or varnished wood; wire gauze for loud-speakers and air-strainers.

This list is by no means complete, and paint should never be applied to anything which it may harm, or prevent from effectively functioning.

All painting should start from the top and work downwards. When painting an interior compartment it should first be swept clean, and then deck cloths should be laid down and furniture or fittings covered over; the deckhead should be painted first, and then the bulkheads, working from the farthest corner towards the door.

Paint on bulkheads and screens usually begins to deteriorate at the bottom, close to the deck, and if painted in a light colour a narrow strip of a darker shade or different colour, which can be renewed as required, should be painted along the bottom.

When painting around fittings the painter should carry a wad of cotton-waste, or oakum, with which to wipe off while still wet any paint accidentally put on them; and when painting intricate work, such as water-tight doors, a piece of cardboard should be used to cover those parts which are not to be painted.

When working aloft or over the side all paint pots and brushes should be secured by lanyards, and the pots should be hoisted aloft in buckets to prevent splashes from falling on the deck. "Long-toms" (paint brushes lashed to broom handles) should only be used where it is impossible to reach the surface with the ordinary brush, because paint cannot be efficiently worked in with such tools. Special brushes should be kept for rough work such as painting

cable, and for bitumastic compositions such as tar and pitch. Paint will not "take" on bitumastic compositions, so they must be entirely cleaned off before painting.

When using spray-guns, power-worked scaling hammers, or wire brushes, goggles should be worn. If necessary to use a toxic paint in a confined space either a "Pattern 230", or a "Salvus", breathing apparatus should be worn; a Service respirator is useless as it does not provide oxygen.

Brush Painting

Paint Brushes (Fig. 312).—In the Royal Navy three main types of brush are supplied, each in different sizes.

The "flat" brushes are used generally for painting plain surfaces, a 3-inch flat brush being the most suitable for painting large areas. The "sash tools" in their various sizes are used for intricate or delicate work, and for painting corners or crevices into which the flat brush will not reach. The "fitch" or "liner" is used for cutting-in lines.

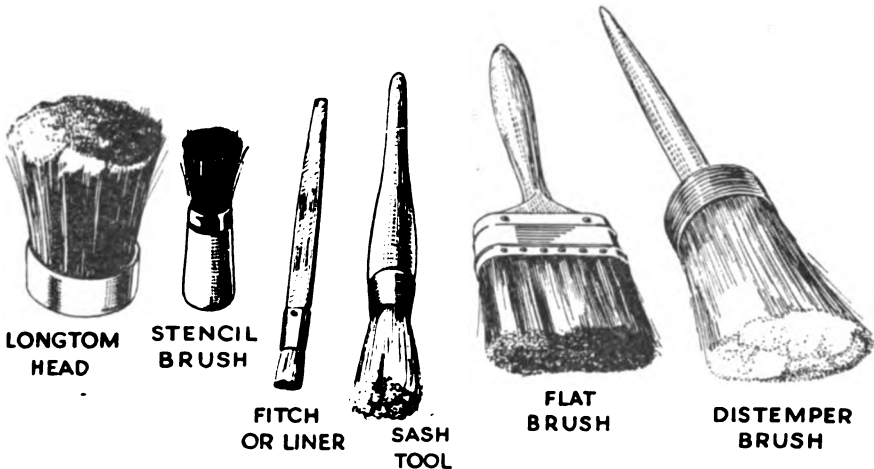


Fig. 312. Types of paint brushes

The set and shape of the bristles of a paint brush are most important. Efficient painting cannot be done with a brush whose bristles are distorted and splayed out, and a brush should therefore not be allowed to rest on its bristles, and should always be hung up by its handle when not in use; when in use it should not be pressed or tapped endwise on its bristles. The bristles should be pliable, neither too long nor too short, and their ends should be worked in to form a chisel-edge. When any brush is drawn from store a hole should be bored through its handle so that a wire can be rove through it to hang it by when not in use, and so that a lanyard can be secured to it when it is being used aloft or over the side.

A new, general-purpose brush should be used on priming work until its bristles have acquired the suppleness and chisel edge required for finishing work. Special brushes such as those used for enamel and varnish, or for intricate work, may be made supple by soaking them in linseed oil for 48 hours and then rinsing them in a solvent such as white spirit; they should be tried out on a clean rag before they are first used.

Immediately after use a brush should always be cleaned in a solvent such as white spirit or naphtha. The bristles should first be dipped in the solvent and as much paint as possible be removed from them with a blunt putty-knife; then the solvent should be worked with the fingers well into the bristles and heel of the brush, and the paint be worked out of them by pressing the flat of the bristles against the side of the container. After all the paint has been worked out the brush should be thoroughly rinsed in clean solvent and spun between the hands to dry it. Solvent which has been used for cleaning brushes should be allowed to stand until the paint has settled to the bottom and then be strained into another container for further use as a cleanser. When the used solvent becomes brown and thick it should be thrown away.

Brushes frequently in use should be hung up with their bristles covered in fresh clean water; brushes used infrequently should, after use, be washed in warm soapy water and then laid flat in their stowage. All paint brushes and pots should always be returned to the paint shop after the day's work is over.

Brush Work.—Painting is a job which requires skill and the correct technique. The brush should be held between the thumb and the first three fingers, as illustrated in Fig. 313.

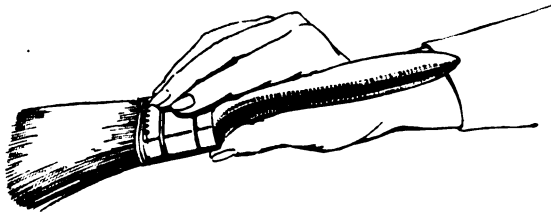


Fig. 313. How to hold a paint brush

The paint pot should not be more than two-thirds full, and a stick should be provided to keep the paint well stirred. The bristles should not be dipped more than half-way into the paint, and should be pressed gently against the inside of the paint pot to remove excess paint; a brush which is too full leads to messy work. The paint should be applied firmly, with smooth, even strokes of the brush, backwards and forwards across the surface, the brush being held at an angle of about 45 degrees to the work. The initial strokes, called "laying-on", should be made horizontally over an area of about four square feet, and they should then be crossed by vertical strokes called "laying-off", the last of which should be made upwards; the paint will thus be worked in well and evenly and leave a smooth surface with a faint grain.

The work should be continued downwards in this way until the first "fleet" is completed, and the second fleet should be started next to it, working down from the top as before. When painting interior girders and other similar structures the paint should be laid-on across, and laid-off lengthwise. If unskilled men are employed on rough brush work, such as painting a ship's side, they may produce a more even coat by laying-on up-and-down and laying-off fore-and-aft.

The art of painting lies in working quickly so that each fleet is married smoothly to its predecessor before the paint sets and becomes unworkable. Paints vary considerably in consistency and drying properties, and brushwork must be modified to suit the peculiarities of the paint used. A thick paint

requires more brushwork than a thin paint, and a quick-setting paint requires narrower fleets and faster work. Paint is more difficult to work in cold weather, but in hot and dry weather it sets more quickly.

The synthetic-resin paints provided for H.M. ships require more "working in" than an oil paint, but thinners should not be added to these paints to facilitate their application by brush because this will upset the balance of their constituents and result in a loss of gloss and durability. A small quantity of thinners may, however, be added to these paints to facilitate their application by spray-gun.

Paint should be put on thinly; if applied too thickly it will not dry properly and will have a poor appearance. It should never be dabbed on, but always worked in with straight or curved strokes of the brush. A flat brush should not be used endways for painting corners and recesses, because this will round the brush and cause it to finger, thus making it useless for cutting in sharp lines; a sash tool should always be used for such work.

Paint should not be allowed to accumulate in the heel of the brush, and to avoid this the paint should be worked out frequently by pressing the flat of the bristles against the edge of the pot. A new brush should be worked in on undercoating before being used for finishing work.

Another coat of paint should not be applied until the preceding coat is thoroughly dry. Paint sets long before it is dry, and a thoroughly dry coat cannot be rubbed off with the fingers. The time taken for synthetic resin paints to dry is from 4 to 8 hours, depending upon the warmth and humidity of the weather; oil paints take at least 24 hours and often much longer in adverse conditions.

Spray Painting

When correctly used the spray-gun affords the quickest, easiest, and most efficient means of painting large surfaces.

The standard equipment required for spray painting comprises a portable air-compressor, an air-receiver, an air-transformer, a paint container, and the spray-gun with the necessary lengths of hose, all of which are illustrated in Fig. 314.

Compressed air at pressures of up to 100 lb. per sq. in. is required to work the equipment; in cruisers and larger ships it is supplied by the ship's low-pressure air system, and in smaller ships by a portable air-compressor driven by a motor from the ship's electric mains.

The air is pumped from the compressor into the air-receiver, which acts as a reservoir, whence it passes through the air-transformer, and while passing through the receiver and transformer it is filtered and dried, and its fluctuating pressure is converted to a steady pressure. The pressure-gauge on the air-receiver records the fluctuating air pressure as it is delivered from the compressor, and that on the air-transformer records the steady air pressure delivered to the paint container and the spray-gun. By means of the regulating valve on the side of the air-transformer the air supply to the paint container is reduced to the required pressure, usually between 50 and 70 lb. per sq. in. Drain cocks are fitted at the base of both the air-receiver and air-transformer, and they should always be opened before and after the equipment is used, to drain off water filtered from the air. Both the receiver and transformer should always be stowed upright.

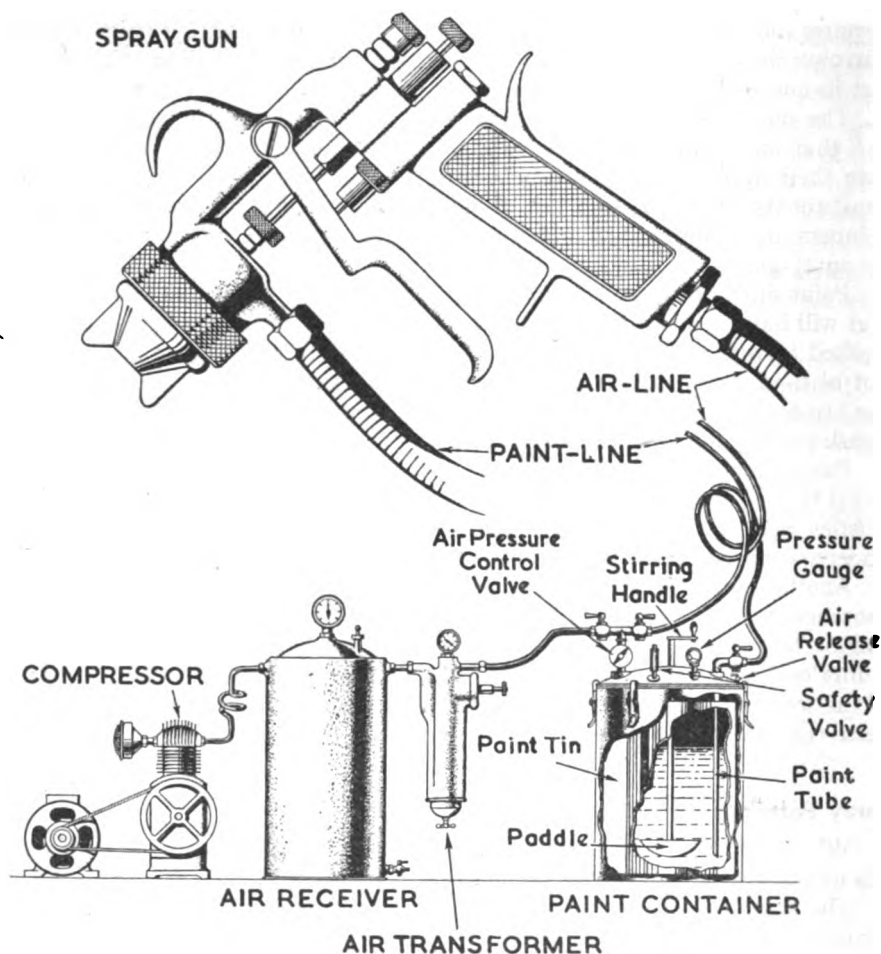


Fig. 314. A spray gun and its associated equipment

The paint container, which is supplied in several sizes, is fitted with an air-tight lid which is clamped in place by hinged clips ; in this lid are fitted a pressure-gauge, a valve for regulating the air pressure, a safety-valve, an air-release cock, a valve for controlling the amount of paint supplied to the spray-gun, and a handle for rotating the paddle with which the paint is stirred. The compressed air, which is delivered from the transformer by a hose to the top of the container, forces the paint from the bottom of the container up a tube and along a hose to the spray-gun. For normal work the paint should be delivered to the spray-gun at a pressure of between 7 and 10 lb. per sq. in. To enable the container to function correctly the following points must be observed :—

- (i) both the container and its fittings must be kept absolutely clean ;
- (ii) the container should not be filled to more than four-fifths of its capacity ;
- (iii) the paint must be free of all impurities and lumps ; and
- (iv) it should be stirred frequently.

The spray-gun has two hose-connections, each fitted with a small gland-packed valve ; the air-hose is connected to the connection in the base of the

butt, and the paint-hose to the connection at the base of the barrel. The trigger controls two valves, one for the paint and the other for the air, and it is adjusted so that its first movement releases the air and its second the paint. When the trigger is pulled the paint is atomised in the barrel of the gun by the air and emerges from the muzzle as a fine, high-pressure, spray. The gun is fitted with two adjustable knobs for controlling the shape and density of the spray; by turning the upper knob the spray can be made either circular or fan-shaped, and by turning the lower knob the density of the spray (*i.e.* the relative amounts of paint and air) can be regulated. The fan-shaped spray is normally used, and the angle at which it is projected from the gun can be altered by unlocking the ring on the muzzle, turning the nozzle in the muzzle as required, and then re-locking the ring. The glands of the valves at the hose-connections should be inspected and cleaned frequently to ensure that they function correctly. The gun has a hook by which it should be hung up when not in use.

Cleaning Spraying Equipment.—The spray-gun and paint container should always be cleaned in the following manner after use. The air supply to the container should be shut off, the pressure inside released, and the lid removed. A wadded cloth should be held firmly over the nozzle of the spray-gun and then the trigger be pressed so that the high-pressure air passes through the gun and the paint-hose in a reverse direction, thus removing any liquid paint from the gun and hose. Then paint in the container should be poured into a clean drum and the container be thoroughly cleaned with solvent, after which sufficient solvent should be poured into the container to clean the paint-hose and the gun. To do this the lid is replaced, the air-hose connected, and the solvent blown through the paint-hose and gun until both are clean. Air should then be blown through the paint-hose to dry it, by attaching it direct to the transformer or the low-pressure air system.

How to use the Spray-gun.—While spraying the spray-gun should always be held with its nozzle from 10 to 12 inches from the surface being sprayed and at right-angles to it. The gun should be moved with a steady free-arm motion, backwards and forwards in straight lines and always parallel with the surface. Tilting the gun, and moving it with a curved motion or not parallel with the surface, are common faults which result in an uneven coat of paint. Each stroke is "feathered" by beginning the stroke before the trigger is pulled and releasing the trigger just before the end of the stroke; correct "triggering" prevents waste of paint by excessive spray at the end of each stroke.

To obtain good results from spray painting the following points should be observed :—

- (i) Correct air pressure from the atomiser to the gun is important; if the pressure is too high the paint will "fog" and result in a poor coat and wasted paint; if too low the paint will not be sufficiently atomised and result in the surface not being evenly covered.
- (ii) Correct regulation of the supply of paint from the container is also important; an inadequate supply will result in pinholes in the coating, and an excessive supply will result in "sags".
- (iii) The length of the air and paint hoses should be kept as short as practicable, because the pressure will drop by about 1 lb. per foot in the paint-hose, and by about 1 lb. per 5 feet in the air-hose.
- (iv) A faulty spray or a poor coating can be caused by the paint being improperly mixed, or by dirty and dried paint being lodged in the nozzle

of the gun. The paint in the container should be stirred frequently with the stirring handle, and the nozzle should be cleaned by removing it and washing it and its component parts in solvent (white spirit or naphtha) and by removing any dirt or paint with a clean rag soaked in the solvent. *On no account should metal implements, nails, or even pins be used to remove paint or dirt from a nozzle or its component parts, because they are made with great precision and the slightest damage will result in a faulty spray.* The gun should always be handled with care, and be hung up by its hook when not in use.

- (v) The gun should be checked frequently to ensure that the first movement of the trigger moves the air-delivery valve only. The gland-packings for the valves should be examined periodically to see that they are tight. All working parts should be lightly oiled every day with a light oil when the gun is in use.
- (vi) All equipment, especially the gun, should be maintained in a thoroughly clean state.

The following points should be observed for the protection of persons engaged on spray painting :—

- (i) The painter should wear a combination suit, gloves, a cloth hood to cover his head and neck, and some form of respirator which incorporates an air-filter, such as the B.E.N. type. No part of the skin should be exposed ; any which cannot be clothed should be well covered with vaseline. The respirator should be maintained in good condition and the wool or other filter be changed frequently.
- (ii) Lead paints are not allowed to be used for spraying as they are particularly injurious to health.
- (iii) For interior spraying adequate ventilation with a forced exhaust should be provided ; all food and clothing should be removed from the compartment ; no naked lights should be in the vicinity ; the decks, furniture, and fittings should be covered ; and polished fittings and glass should be smeared over with vaseline.

Painting the Ship's Bottom

Preparation of the Surface. The underwater surface of the hull is prepared for painting by projecting a blast of wet sand all over it if the necessary equipment is available, or by scaling, scraping and wire brushing it, either by hand or power ; whichever method is used a thoroughly clean and dry surface is essential. When a ship is docked for repainting her bottom any marine growths are scraped off as the water in the dock recedes by gangs of men standing on catamarans and equipped with long handled scrapers. Lines should be rigged on either side from bows to stern just above the waterline to enable the catamarans to be hauled and secured in position. After all mud and marine growths have been removed the scaling, scraping and brushing is carried out from stages rigged on the dock bottom, and the whole surface is then washed or hosed down with fresh water.

A ship is usually docked for renewal of her bottom paint for one or more of the following reasons :—

- (i) because the paint has cracked and peeled, leaving large areas of bare steel showing ;

- (ii) because corrosion or pitting under the paint is evident ;
- (iii) because the bottom is covered with fouling ;
- (iv) because more than 9 months have elapsed since the bottom was last painted.

Application of Bottom Compositions. These compositions may be applied by brush or spray-gun, the latter method being much quicker and more efficient. Each coat of whatever composition is used must be thoroughly dry before the next one is applied. Admar should be allowed not less than 4 and not more than 48 hours for drying, and Pocoptic should be allowed from 8 to 24 hours, the actual time depending upon the humidity of the atmosphere.

Pocoptic is a heavy paint which must be thoroughly mixed before and during application, a mechanical stirrer being used because hand-stirring is not effective. The initial stirring may take from a quarter of an hour to several hours, depending upon the temperature of the composition. In cold weather the composition should be kept in a warm building before use and may be gently heated immediately before it is applied, but on no account may it be heated to more than 100°F. Pocoptic should be applied at a spreading rate of about one gallon to every 150 square feet of surface to give each coat the necessary thickness.

The same compositions are used for "boot-topping", and they are applied in the same way as those used for the remainder of the underwater part of the hull.

GENERAL SHIP MAINTENANCE

Good ship maintenance depends chiefly on cleanliness, and on the frequent and regular inspection and maintenance of gear and equipment. Dirt leads to corrosion, hides defects, and impairs the functioning of moving parts and machinery. No equipment or gear can be kept in good working order by irregular, desultory, or infrequent inspection and maintenance. Captains of Tops should therefore ensure that their respective parts-of-ship are kept perfectly clean, and they should make out detailed routines for the inspection and maintenance of the gear and equipment with which they are charged and see that these routines are carried out. The intervals between routine inspections and maintenance will depend upon the type of gear, the use to which it is put, and the climate. In general, maintenance and inspection should be carried out more frequently in tropical climates than in temperate climates.

Maintenance of Equipment and Fittings

STOWAGE OF GEAR

Insistence on correct stowage is of great importance. Gear in frequent use, such as wash-deck gear, should be marked with the part-of-ship symbol ; every item should have its allotted stowage and be restowed after use, especially when the day's work is finished. Paint pots and brushes should be returned to the paint shop. No gear required for general ship work should be locked up.

DEFECTS

A defect book should be kept by each captain of a top, and in it should be noted all gear requiring replacement or repair. Repairs which are of an urgent nature, or beyond the capacity of the part-of-ship, should be reported. Men should be encouraged to keep a lookout for defects and report them at the earliest opportunity.

STANDING RIGGING

Shrouds, stays, guys and all other standing rigging should always be set up taut ; the rigging screws should be kept locked or moused to prevent them unscrewing, and their screws should be well engaged in their sleeves. The rigging should be blacked down periodically with Stockholm tar ; if this is not available a mixture of Stauffer's grease and plumbago can be used instead, but it is liable to melt in hot climates or in the vicinity of funnels. The rigging screws should be kept greased and fitted with "gaiters". Particular attention should be given to davit guys to ensure that the davits are correctly aligned ; incorrect alignment is a frequent cause of the boat's falls chafing at the leading or upper blocks. Guardrails and chains round hatchways should always be set up correctly and inspected periodically.

RUNNING RIGGING AND FITTINGS

All running rigging should be inspected periodically for frayed or broken fibres or wires, and wire rope should be kept well lubricated with boiled linseed oil. Cordage should be slacked off in rain or dew. Careful attention should be given to the lead of the ropes to see that they do not chafe anywhere.

Hawsers should be inspected periodically for frayed or broken fibres or wires, and wire hawsers should be lubricated periodically with boiled linseed oil, or petroleum jelly or tallow. The ends of cordage hawsers should be pointed and becketed. Cordage hawsers should never be stowed when wet.

Slings, especially their eye-splices, should be inspected frequently, and each sling should be marked with its safe lifting load. Wire rope slings should be kept well lubricated.

Splices and seizings should be inspected frequently. New splices in wire rope should be dipped in Stockholm tar before being served.

Parcelling and service on ropes should be examined frequently and renewed periodically, particularly on fibre rope, because these coverings are not water-proof and the rope beneath them may quickly rot. A rope is parcelled or served not for the sake of appearance but to protect it from chafe, or to protect whoever handles it (from the ends of the wires, in the eye splice of a wire hawser for example). If a wire rope is canvassed, the lizard of a boat boom for example, it should be well tarred after it is wormed and before it is canvassed. If a metal fitting such as an awning stanchion is to be canvassed it should be thoroughly cleaned and painted, otherwise it will rust and the rust will mark and rot the canvas covering.

Blocks should be inspected periodically for wear, the alignment of their sheaves, and bent or damaged cheeks and swallows. They should be oiled weekly.

The Bolts of shackles should be kept free and lightly greased ; if the bolt is rusted in, the shackle is useless.

Metal gear which is not in frequent use, such as slips, stoppers, and special shackles, should be given a coating of boiled linseed oil and their working parts should be greased.

Ropes' ends. Any rope which has to be rove through a block should be pointed. Boats' painters should be pointed and grafted. The ends of lacing should have two whippings, half-an-inch wide and half-an-inch apart.

Fittings. The working parts of all fittings, such as the bearings of hawser reels, the heels of davits and derricks, and the brackets of gipping spars, should be greased periodically.

Securing-pins and forelocks should be secured to their parent fittings with lanyards.

LIFE-RAFTS AND FLOATS

These rafts should be inspected periodically to ensure that their equipment is complete and in good order. Particular attention should be paid to their slings and slips.

FIRE APPLIANCES AND HOSES

These should be periodically inspected and tested.

WATER-TIGHT FITTINGS

All water-tight fittings should be inspected and tested periodically.

Cleaning Ship

DECKS

Before a deck is scrubbed it should be well swept down so that the dirt will not be scrubbed into it. Two hands should be detailed each side to scrub the beadings with sand and canvas, and one or two hands should be detailed to scrub gratings, corners, and any special woodwork. The remainder of the hands should work together and scrub the deck, from forward aft and with the grain of the wood. Water should be laid on sparingly with a hose, and flooding the deck and hosing out corners should not be allowed; a little sand thrown down as the decks are scrubbed helps to remove ingrained dirt. After the deck has been thoroughly scrubbed it should be washed down carefully and then dried with swabs and squeegees. Ringbolt sockets should be dried out and splashes of salt water wiped off the paintwork with a cloth dipped in fresh water. Particular attention should be paid to corners and recesses which are inaccessible to brooms.

A deck can be thoroughly cleaned with holystones, sand and a little water, but this should only be done occasionally, especially if the deck is of soft wood, as in time it wears the deck down appreciably. Holystoning should always be done with the grain of the wood, not across it.

An alternative method to holystoning, but not so effective, is to scrub well into the deck a solution of soda, soft-soap and cleaning powder, mixed with hot fresh water. After mixing, the solution should be allowed to stand until cold and then be thoroughly stirred before applying it. After it has been well scrubbed in it should be left as long as possible and then scrubbed down repeatedly with fresh water. Caustic soda mixed with fresh water, in the proportion of 1 to 300, may also be used occasionally to clean a very dirty deck; but it should be borne in mind that any solution containing soda ruins paintwork, and that every precaution should therefore be taken to protect paintwork from splashes.

Oil or grease stains on decks should be removed by scraping the affected surface lightly, and then applying a mixture of lime and fresh water to it. This should be left on until the oil is absorbed by the lime; it should then be scrubbed off and more lime be applied, if necessary, until the stain is removed.

The application of lime will only be effective on a dry and sunny day. Decks should be limed before ranging cables or hawsers to protect them from grease.

PAINTED SURFACES

Paintwork should be cleaned with fresh water and clean cloths ; if necessary hard-soap may be used, but not on enamel. Stains may be removed by carefully applying powdered bath-brick with a damp cloth. Soda, cleaning powder, soft-soap or caustic soda should never be used to clean paintwork, as they destroy the paint.

WOODWORK

Bare woodwork should be scrubbed with salt water or sand and salt water, or with shark-skin ; but when scrubbing boats sand should be used sparingly because it will drop into the bilges, where it is difficult to remove. Soap should not be used on woodwork because it is liable to turn it yellow and may produce a greasy surface. Polished wood should be washed with fresh water and then thoroughly dried ; an occasional rub with a cloth moistened with linseed oil will keep the surface fresh. Polished furniture should be treated with furniture polish. Old varnish can be removed with a coating of lime or strong caustic soda ; the surface should then be washed with fresh water and thoroughly dried before it is revarnished.

BRIGHTWORK

Where practicable, brightwork fittings should be removed for cleaning ; where this is not practicable a stencil should be made to protect the surroundings of the fitting from the metal polish. Emery paper should only be used to smooth down rough castings or to remove a heavy accumulation of rust. Brass should be cleaned with metal polish, rubbed in vigorously and polished with a rag or paper. Steel and very dirty brass, or brass covered with verdigris, should be cleaned with powdered bath-brick and metal polish rubbed on with a piece of canvas. At sea, brass can be protected against tarnish by applying a light coat of clean oil or mineral grease. Metal mess-traps are best cleaned in soapy water with a wad of wire wool ; caustic soda or similar strong solutions will eat into and destroy the polished surface of tinned mess-traps, and unless very thoroughly washed out afterwards they may affect the food.

CANVAS

Awnings should be hand-scrubbed with salt water, and then washed with fresh water ; if particularly dirty they may be washed with fresh water and soap and then washed down with fresh water. Frequent scrubbing wears out awnings, so every care should be taken to keep them from getting dirty ; before spreading or furling an awning the decks should be swept, and when awnings are made up they should be carried, never dragged along the decks, and they should always be laid or stowed on chocks. Heavy sails should be hand-scrubbed with salt water, but light sails should be washed with soap and fresh water ; after scrubbing or washing, the sails should be rinsed in fresh water and thoroughly dried before they are made up and stowed in their covers. Paint can be removed from canvas by rubbing in hard-soap while the paint is still wet ; the paint will then dissolve when the canvas is next scrubbed.

MISCELLANEOUS

Glazed surfaces of china, earthenware, tiles and enamel ware should be

cleaned with soap and fresh water. On no account should abrasives be used as these will destroy the glazing.

Corticene and linoleum are best kept clean by polishing them with floor polish. Where this is not practicable they should be cleaned occasionally by washing with soap and warm fresh water, care being taken to keep the water from getting beneath them. Corticene and linoleum have a hard protective surface, and once this is damaged the material will soon rot ; they should not therefore be scraped or rubbed with harsh abrasives, and paint marks and stains should be removed only with turpentine or shale oil.

Glass should be cleaned with warm fresh water and soap, and then be polished with soft paper such as newspaper. Paint can be removed from glass by wetting it and then rubbing it with a copper coin laid flat.

Lagging and insulation should be brushed with a soft brush, washed with a damp cloth rinsed in fresh water, and then repainted with distemper.

Leather, hide and oil-cloth should be washed with fresh warm water and soap. Dubbin or neat's foot oil should be well rubbed into leatherwork which is exposed to the weather.

Perspex should be cleaned with a soft cloth and the special cleaner supplied for it.

Rubber should be cleaned with soap and fresh water, and then thoroughly dried. Paint splashes can be removed with pumice stone. Powdered chalk should be applied to the sealing strips of water-tight fittings to prevent the rubber from getting sticky. Paint, oil, or grease should not be allowed to come in contact with rubber.

CHAPTER XVI

Naval Communications

FLAG SIGNALLING

Terms used in Flag Signalling

Hoist. The order to display a flag signal. Also describes a combination of flags on one halyard.

Down. The order to haul down a signal.

Close-up. A flag signal is said to be "close-up" when its top is touching the block at the point of hoist.

At the Dip. A flag signal is said to be "at the dip" when it is hoisted two-thirds of the way up towards the point of hoist.

Dip. To lower a signal from the close-up to the dipped position.

Bend On. To clip the flags of a hoist together, and to clip the head and tack of the hoist to the halyards ready to hoist when ordered.

A Display. Several hoists flown simultaneously.

Successive Displays. Several hoists or displays made consecutively to form one signal.

A Tackline. A length of halyard, from 3 feet to 6 feet in length (according to the size of flags in use), fitted with an Inglefield clip at each end. Used to separate flags in a hoist which, if hoisted at the normal distance apart, might convey a different meaning to that intended.

Above and Below. These terms are used to describe the relative positions of the different parts of a hoist or signal. For example, when addressing a ship or boat her callsign is made above, *i.e.*, precedes the signal. When denoting, or referring to, a ship or boat her callsign is made below, *i.e.*, follows the signal.

Superior and Inferior Positions. These terms are used to describe the relative positions of different flag signals on the same mast.

Positions of Hoists and Order of Reading

The mast of a modern warship does not afford the same facilities for flag signalling as did that of the older man-of-war. Destroyers and certain other types of ship are fitted with only one signal yard, but the following rules generally apply :—

the masthead and the upper yard-arm or upper spurs are termed "superior positions", and the lower yard-arm and the lower spurs are termed "inferior positions"; all hoists in superior positions are read before those in inferior positions. The hoists on the starboard side are read before those in the same position on the port side, and the outer hoist is read before the inner hoist, the order of reading being: "starboard outer", "starboard inner", "port outer", "port inner".

Symbols Used to Represent Flags and Pennants

A system of shorthand is used in writing down flags, or signals containing flags, whatever the signal system employed. The signs used for special flags and pennants are given against each in the coloured plates following page 546.

How to Make, Answer, Execute, and Cancel a Signal

To Make a Signal. The meaning of a signal is normally conveyed when it is hoisted close-up, but certain signals convey an alternative meaning when displayed at the dip, *e.g.*, *Uncle* when heaving in cable.

To Answer a Signal. The signal is normally answered by repeating the signal at the dip as soon as it is seen and close-up when the meaning is understood. In certain cases instructions may be given that ships are to answer signals by use of the *Answer* used in the same manner as for repeating.

If the signal conveys an order to carry out a manœuvre or movement, repeating the signal or hoisting the *Answer* close-up, also signifies readiness to execute that order. When *Answer* is used, if a further signal is hoisted after acknowledgment has been given, *Answer* is to be dipped and rehoisted close-up when the subsequent signal is acknowledged.

To Execute a Signal. The originating ship hauls down the signal, and the ships addressed then haul down the repetition of the signal or *Answer*.

The action ordered by most signals is not begun until they are hauled down, but in certain special signals action is taken when they are dipped, instructions to this effect being given in the code.

In an emergency, or for drill purposes, it is sometimes necessary that a signal shall be obeyed immediately it is understood, but on such occasions a special flag conveying this instruction is hoisted with the signal.

To Cancel a Signal (R.N. only). To cancel a signal already hoisted *Negat* is hoisted on an adjacent halyard in a superior position. If suitable halyards are not available *Negat* must be hoisted as high as possible and the signal to be cancelled must then be lowered slowly until it is lower than *Negat*; both are then hauled down together when all addressees have acknowledged.

Callsigns

A ship's visual callsign consists of an alphabetical flag indicating the type of ship, hoisted above to two or more numbered pennants which indicate her number in the *Visual Callsign Book*.

A ship's visual callsign is commonly referred to as her "pennants", and every seaman must be able to recognise his own ship's pennants; for example:—

B p2 p3 = *VANGUARD* (Battleship)

D p8 p6 = *AGINCOURT* (Destroyer)

To address a ship, her callsign is hoisted above the signal.

To denote or refer to a ship, her callsign is hoisted below the signal.

A signal addressed to all ships present is hoisted without any callsign above it, and it is answered by all ships.

A boat's callsign consists of *Queen* (the boat flag) above a numbered pennant indicating the particular class of boat required. An individual boat of any class may be further identified by a numeral flag below. For example:—

Q p1 p4 = Cutters. Q p1 p4 flag 2 = Second cutter.

If necessary to identify a boat belonging to a particular ship, the ship's callsign is hoisted superior ; for example :—

B p2 p3 Q p1 p4 flag 2 = Cutters belonging to *Vanguard*

Note :—Full details are contained in the *Minor Landing Craft and Boats' Signal Book*.

Signals displayed when Working Cables

When working cables, direct telephonic communication is established between the bridge and the forecastle, and, in addition, visual signalling is used between the forecastle and the bridge to indicate the state of the anchors and cables. By day this is done by hand flags and at night by flashing, using the following code :—

Numeral flags 1 to 9 indicate the particular length of the cable which is being worked through the hawsepipe.

Uncle horizontally indicates anchor is up and down. (By flashing—UD.)

Uncle vertically indicates anchor is aweigh.

Able vertically indicates clear anchor.

Negat vertically indicates foul anchor.

Charlie horizontally indicates anchor clear of the water. (By flashing—CW.)

Charlie vertically indicates anchor secured.

The following example is given to describe the use of the numeral flags when working cable. As the anchor is let go *flag 1* is held aloft to indicate that the first length of cable is running out through the hawsepipe. As the joining shackle between the first and second lengths passes through the hawsepipe *flag 2* is held aloft, thus indicating that the second length of cable is passing through the hawsepipe. The passage of each successive length of cable is indicated in a similar manner. The same applies when heaving-in cable ; when, for example, the joining shackle between the third and fourth lengths of cable passes up through the hawsepipe, *flag 4* is lowered and *flag 3* is held aloft in its stead. The links on each side of the joining shackles are marked to enable the latter to be distinguished from each other.

To indicate progress in working cables to other ships in the vicinity *Uncle* is hoisted at the yard-arm on the appropriate side and used as shown in the following table.

<i>Operation</i>	<i>Progress</i>	<i>Signal</i>
Anchoring	Anchor let go	<i>Uncle</i> at the dip on appropriate side.
	Cable veered to correct length	<i>Uncle</i> close-up.
	Cable secured	<i>Uncle</i> hauled down.
Mooring	Anchor let go (<i>Port</i> or <i>Starboard</i> may be used to indicate side)	<i>Uncle</i> at the dip on appropriate side.
	Cable middled	<i>Uncle</i> close-up.
	Cable secured	<i>Uncle</i> hauled down.
Weighing	Am heaving in (when un-mooring <i>Port</i> or <i>Starboard</i> may be used to indicate side)	<i>Uncle</i> at the dip on appropriate side.
	Anchor aweigh	<i>Uncle</i> close-up.
	Ready to proceed	<i>Uncle</i> hauled down.

Note :—By night, a white light is used instead of *Uncle* and worked in the same manner.

Captain's Anchor Flags :—These consist of two small hand flags, one red and one green with a white anchor design on each, which are used by the Captain to indicate the exact instant at which to let go the port and starboard anchors, respectively.

Example of Use of Anchor Signals. The following example shows the cable signals used by a ship in daylight when coming to with a single anchor by day.

The Captain shows the *Red anchor flag* from the bridge, meaning "Stand by to let go port anchor," and this is repeated by the Cable Officer on the forecastle.

Uncle, made up ready for breaking, is hoisted at the dip at the port yard-arm.

The Captain lowers the *Red anchor flag* smartly, whereupon the slip is knocked off the port cable and the anchor let go.

Uncle is broken at the dip at the port yard-arm.

The cable numeral flags are shown on the forecastle as the cable runs out.

Uncle is hoisted close up when cable is veered to the correct length.

Uncle is hauled down when the cable is secured.

Minor Landing Craft and Boat's Signal Book

This book, commonly known as the "M.S.B.", contains a simple code for use between ships, minor landing craft, and boats of the Royal Navy, and naval signal stations.

When making a signal to a boat by flags the code is identified by the boat's callsign preceding the signal.

Boat's Callsigns :—

Qp0 All boats.	Qp9 Whaleboats, whalers.
Qp1 Admiral's barge.	Qp1p0 Dinghies, wherries, skiffs.
Qp2 Chief of Staff's barge or gig.	Qp1p1 Boats under sail.
Qp3 Staff gigs or motorboats.	Qp1p2 Boats under oars.
Qp4 Captain's gig.	Qp1p3 Galleys and gigs.
Qp5 Motorboats.	Qp1p4 Cutters.
Qp6 Motor launches.	Qp1p5 Reserved for local al-
Qp7 Motor whaleboats.	to location by Com-
Qp8 Amphibious boats.	Qp5p0 manding Officers.

A particular boat of a class is identified by a numeral flag following the pennant.

A boat belonging to a particular ship is identified when necessary by the ship's callsign above the boat's callsign.

Examples :— (i) Motorboat number two : Qp5 flag 2.

(ii) *Dido's* motorboat number two : Cp3p7 Qp5 flag 2.

Care of Boat's Signal Book :—The Coxswain is responsible that the *Boat's Signal Book* is maintained in good condition. To ensure this it is to be kept in a special painted canvas cover, on which the name of the boat and the flags and pennants comprising the boat's visual callsign (which is also the "boat's recall") are painted.

The International Code

This code of signals is designed for use between ships of all countries, and so is printed in seven different languages, namely English, French, German, Italian, Japanese, Norwegian and Spanish.

The Code is compiled in two volumes, one for visual signalling and the other for radio. Each volume comprises a complete code by itself.

Volume 2, for radio only, consists entirely of five-letter groups.

Volume 1, for visual signalling only, contains the code group sections described below :—

Single letters. Navigational and miscellaneous signals of an urgent nature, for example :—

- (i) R = the way is off my ship, you may feel your way past me ;
- (ii) W = I require medical assistance.

Two letters. Other important signals, mainly those affecting safety or for use in emergency, for example :—

AS = I am aground and require immediate assistance.

Three letters. The general code or “vocabulary”, giving the more common phrases in use at sea, and words for building up other phrases and sentences.

Four letters. The geographical section, which gives the countries, place-names and landmarks, etc., bordering the navigable waters of the world, arranged alphabetically. All geographical groups begin with the letter “A.”

INTERNATIONAL V.S. PROCEDURE

As merchant ships do not normally carry specially trained signal personnel the procedure rules have to be as simple as possible, and they differ in detail from Naval procedure.

Details of the procedure to be used are contained in Volume I of the *International Code*. The principal points in this procedure are given below :—

Code Indicator. When using flashing to transmit a coded message a special “Indicator” must be transmitted as the first group. The group “PRB”, meaning that “The following is coded from the *International Code of Signals*”, is used for this purpose.

Flag signalling. The flags used are :—

- the alphabetical flags ;
- numerals 1 to 9 (pennants) ;
- the three substitutes ;
- the International Code (Answering) pennant.

No special flags have to be carried by H.M. ships for this purpose as the International Code flags are all contained in the Naval code of signal flags.

When a warship hoists a signal from the International Code, the International Code pennant must be hoisted at the same time in a conspicuous position and kept flying until signalling is finished. This is necessary in order to avoid confusion with the Naval code of signalling.

INTERNATIONAL SIGNAL LETTERS

Signal letters are contained in a separate publication known as the “*Berne List*”, so named because it was compiled as the result of an international

convention held at Berne in Switzerland ; they consist of four-letter groups. Signal letters of British ships are also published in B.R. 70, *Signal Letters of British Ships*.

Signal letters are used as callsigns, both in visual and in radio signalling ; also in the text of a message when it is necessary to indicate a ship's name.

Flag Signalling Equipment

SIGNAL FLAGS AND PENNANTS

Flags are either rectangular, triangular, or "burgee" shaped (*i.e.*, rectangular with a swallow-tail). Pennants are elongated and narrowed down towards the "fly" to about one quarter of their breadth at the "hoist" (see Fig. 315 (b)).

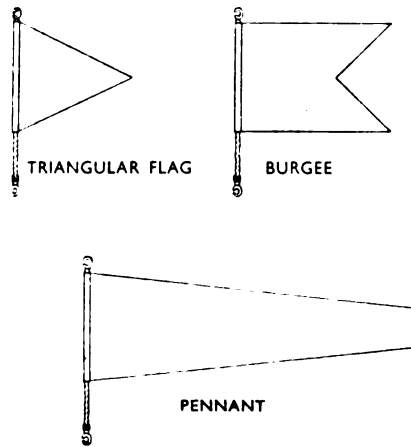
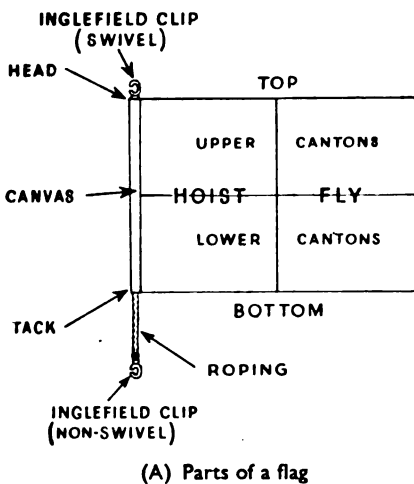


Fig. 315

The swivel-clip at the head is fitted to prevent the flag rolling itself round the standing part on hoisting.

The long end of roping at the tack provides a spacing when several flags are hoisted together ; it also enables the signalman easily to distinguish the head and tack, and thus prevents him bending on a flag upside down.

Signal flags are made of bunting, which is manufactured from very light, tough and durable woollen material ; wool is safer than cotton material as it will smoulder but not blaze if set on fire.

Naval bunting is supplied in bolts of 150 yards, 19 inches wide ; it can be identified by extra threads running through its length or warp at every 6 inches of the width.

A "breadth" of bunting is nine inches. This standard of measurement is used for ensigns, Union flags and Admiral's flags, but not for signal flags. The length of an ensign and a Union flag is twice its breadth ; thus, a "six-breadth" White Ensign is 4 ft. 6 in. broad and 9 ft. long. The length of an Admiral's flag is one and a half times its width.

Signal halyards for flag hoisting are made of soft-laid sisal. To give added flexibility a proportion of the yarns in each strand of the halyard is reverse-spun.

Halyards are made in three sizes, $1\frac{1}{4}$ -inch, $1\frac{1}{8}$ -inch and 1-inch, and are supplied in coils of 122 fathoms.

Naval flags are supplied in five sizes, numbered 3, 3a, 4, 5 and 6 ; in addition some very large flags are supplied for special purposes. Size 6, the smallest, is that used by boats and small craft and for cable flags.

Details of the dimensions of all flags, with their pattern numbers, are contained in the *V.S. Material Handbook*. The pattern number of a signal flag is stamped on the canvas near its head, and the first figure indicates the size e.g., 313 L indicates No. 3 size flag L.

Signal blocks (Patt. 398B) are specially supplied for flag signalling and are made of gunmetal. They are single-sheaved and fitted with a swivel spring-hook, and are secured aloft by eyebolts fitted on the yards and other signalling positions.

Inglefield clips, one of which must be of the swivel type, are eye-spliced into the ends of the halyards. Before taking the final tuck the strands must be halved from the middle, so that the head of the hoist will run easily close up to the block instead of jamming in it. The splicing is finished off with a broad Spanish whipping of sailmaker's twine.

SIGNAL HALYARDS

In dry weather by day, halyards must be kept taut and belayed to the cleats provided, so that they are shipshape and ready for instant service.

To belay a halyard the lee part is led under the lower part of the cleat and secured with a Blackwall hitch, so that about 18 inches of halyard is left hanging with the clip at its end. The weather part is then led under the lower part of the cleat and hauled taut, a bight of its spare end being then taken behind its standing part, then looped over the lower part of the cleat, and then hauled taut ; the long spare end is then made into a neat coil and hung over the upper part of the cleat.

In wet weather the halyards must be well slackened off to allow for shrinkage ; with sisal this shrinkage is very considerable.

When flag signalling is finished for the day the clips are clipped together and rounded up about 6 feet above the cleats, and the halyard parts are then belayed separately by taking one turn, and then two figure-of-eight turns, round the cleat. The spare bight is then coiled neatly and secured over the upper part of the cleat, so that no one will trip over it during the dark hours and the deck will be all clear for scrubbing in the morning.

To Belay Halyards on which a Flag Signal is Hoisted. Ensure that the hoist is close up and clear by taking one part of the halyard in one hand and the other part in the other hand, and then jerking the head of the top flag smartly against the block. Next, belay the standing part, keeping it well taut ; the first turn should be round the cleat, then once downward and upward in a figure-of-eight. Then belay the tack in the same manner, and make up the remaining bight of halyard into a neat coil and hang it over the upper part of the cleat.

*Note :—*Never belay halyards with a jamming hitch if a signal is flying from them.

STOWAGE OF SIGNAL FLAGS

Flag lockers are supplied on the flag deck, and each flag and pennant has a separate pigeon hole clearly marked with its appropriate letter, figure, or special sign.



Fig. 316. A flag deck

In boats, or temporary signalling positions, canvas wallets are provided instead of lockers.

Flags are always stowed with the two clips (head and tack) together and clearly showing to one side of the lettering. This is done by gathering the bunting in one hand and the clips in the other, and then ramming the bunting well home in the pigeon hole.

BREAKING A FLAG OR PENNANT

Some flags and pennants must be broken after hoisting, that is, let fly in their correct position at an exact moment. This is done when first hoisting or when shifting an Admiral's flag, with a masthead ensign when dressing ship or during the firing of a gun salute, and for certain signals such as with *Uncle* when letting go an anchor. Breaking a flag or pennant ensures that the bunting flies clear, and lessens the risk of fouling obstructions aloft whilst being hoisted.

To make up a flag for breaking :—

- (i) double the flag lengthwise, with the " tack " towards the deck ;
- (ii) double it in the same manner once again or more often, according to the size of the flag, finishing with the head on top ;
- (iii) roll the flag, beginning from the fly and keeping all taut to ensure a neat and level roll ;
- (iv) take a turn with the tack roping round the middle of the flag ; with a large flag a second turn may be necessary ;
- (v) draw a bight of the spare roping through the turn, haul it well taut and tuck the end of the bight under again in the same direction, thus avoiding loose ends.

To break the flag :—

bend on and hoist when required ; when close up, belay the standing part ; with the other part held loosely stand by for the order to break ; on the order being given, haul smartly, and, as soon as the flag breaks out, cast off the standing part and jerk the head of the flag vigorously against the block until the bunting is flying clear and close up ; then belay the halyards.

HOISTING AND SECURING ENSIGNS AND JACKS

Whenever colours are worn, constant attention is necessary to ensure that the ensign and jack are kept close up, clear and shipshape. If hanging foul, down by the head, or with halyards slack, they present a slovenly appearance and bring discredit on the ship or boat concerned.

Ensigns and Union flags above a certain size are fitted with eyelet holes in the canvas to enable them to be laced to their staffs. This ensures a neat and shipshape appearance by keeping the ensign or jack close in to the staff.

Take a length of codline for the lacing, and back-splice its ends. Bend the ensign or jack on to the halyards, making sure that the head will traverse the lee side of the staff ; then take a turn with the halyards, well clear of the staff and so that all the eyeletted canvas is within easy reach.

Begin lacing upward, through the lower eyelet hole, then round the staff, and successively in spiral turns until the upper eyelet hole is reached, where the upper end of the lacing is made fast with a round turn and two half hitches. Ease off the lacing to ensure a clear run over the staff, then gather in all the bunting out of sight until the moment of hoisting.

After hoisting take the standing part in one hand and the tack and lacing in the other, and, keeping the lacing slack in the hand, work the head against the truck until all parts draw taut with the head close up under the truck. Now belay the standing part, then the tack, and finally the lacing, taking care that the roping of the ensign or jack rides vertically on the staff. Coil the spare bight of halyard and the lacing end neatly, and hang the coil over the upper part of the cleat ; alternatively, stow the spare bight and ends in a canvas pocket near the heel of the staff.

TO FIT A HEADSTICK

A " headstick " is a rounded piece of wood fitted into the canvas at the head to ensure that the ensign or Union flag rides squarely and close up under the truck of the staff. All the larger sized ensigns and Union flags are supplied with headsticks already fitted, but with smaller sizes it is necessary to fit them locally.

To fit a headstick, open out the seam of the canvas at the head for about 6 inches and put a whipping on the roping at the lower part thus exposed. Unmake the splice and remove the swivel clip. Unlay the roping down to the seizing and unravel the strands ; thin out about half the yarns from the middle.

Take a rounded piece of wood 5 in. long and $\frac{3}{4}$ -in. diameter, insert it in the middle of the unlaidd yarns and lay on a rough seizing to hold it in place, finishing the seizing at the top end of the wood.

Lay back the remaining ends of the yarns evenly, trim them off at the lower end of the wood, and then serve over with sailmaker's twine.

Replace the canvas and stitch it in position over the headstick, taking care that the roping lies taut and square inside.

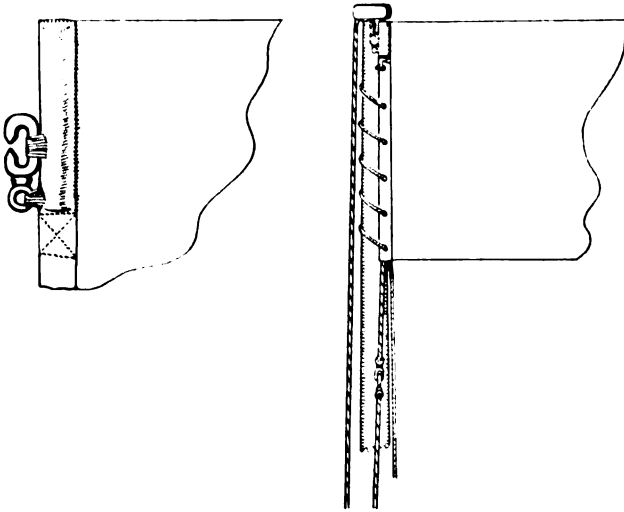


Fig. 317. Fitting a headstick

With sailmakers' needle and twine, seize the clip on to the outer edge of the canvas so that the upper part of the clip is about 2 inches below the head of the canvas.

SIGNALLING PROCEDURE

Signalling by the Morse or Semaphore codes or by radio telephony provides a means by which orders and information are conveyed over distances too great for the range of the natural voice. To achieve brevity and minimise errors the rules for transmission and reception must be clear and simple, and the language employed must be standardised in words and phrases which allow no possibility of misunderstanding. To accomplish this there are special rules, known as "procedure", for operating the various systems.

Full details of procedure are contained in the special books supplied to the Communication department, but certain of these rules must be understood by all seamen so that no mistakes can arise in signalling, recording, or verbal reporting.

In particular, the three prime rules for signalling are :—

- (i) always remember the man at the other end ;
- (ii) do not transmit faster than you can receive ;
- (iii) use the correct procedure.

Procedure Signs and Phrases

To avoid misunderstanding and to achieve brevity every message is made in a standard form and by means of a uniform method, known collectively as "procedure". This consists of a code of letters or signs used to signify the various words or phrases which are commonly used to pass a message. The phrases are known as "prowords", which are used in all methods of voice transmission, and these are recorded by symbols called "abbreviations". In V.S. or W/T the "prowords" are transmitted by symbols called "prosigns".

The following list gives the prowords in most common use, the abbreviations used in writing them down, and their equivalent prosigns.

<i>Voice Transmissions</i> (<i>Prowords</i>)	<i>As Written Down</i> <i>in Voice Recording</i> (<i>Abbreviation</i>)	<i>V/S or W/T</i> <i>Transmissions</i> (<i>Prosign</i>)
Action (in the address)	TO	TO
All after	AA	AA
All before	AB	AB
Break	=	<u>BT</u>
Correction	C	C
Deferred	NM	NM
Disregard this transmission	DISR	EEEEEEEE +
Do not answer	DN	F
Emergency (Precedence Indicator)	O	O
Exempt	XMT	XMT
Flash (Precedence Indicator)	OC	OC
Groups	GR	GR
How do you hear me ?	HR	Not applicable
I read back	IRB	Not applicable
I say again	ISA	<u>IMI</u>
I spell	ISP	Not applicable
I verify	IVY	C
Info	INFO	INFO
Message for you	MF	Not applicable
Operational Immediate (Precedence Indicator)	OP	OP
Originator	FM	<u>FM</u>
Out	+	<u>AR</u>
Over	K	K
Priority (Precedence Indicator)	P	P
Read back	RB	G
Relay to	RYT	T
Roger	R	R
Routine (Precedence Indicator)	R	<u>R</u>
Say again	SA	<u>IMI</u>
Send your message	SYM	Not applicable
Spell	SP	Not applicable
That is correct	C	C
This is	DE	DE
Time	TM	Not applicable
Unknown station	UU	<u>AA</u>
Verify	VY	<u>J</u>
Wait	W	<u>AS</u>
Wait out	W +	<u>AS</u> <u>AR</u>
Wilco	WC	Not applicable
Word after	WA	WA
Word before	WB	WB
Words twice	WT	Not applicable
Execute to follow	<u>IX</u>	<u>IX</u>
Execute	(-----)	IX ----- +
Stand by	SB	Not applicable

- Notes.*—(i) A horizontal line or “ bar ” over a prosign indicates that it is transmitted as one sign instead of making the letters separately as in other cases.
- (ii) The “ Execute to follow ” and “ Execute ” are used when it is required to indicate the exact moment when a movement or order shall be commenced.
- (iii) The date time group (DTG) indicates the time at which a message was ordered to be sent. It is *NOT* included in a message when the “ Execute to follow ” is used.

Voice Procedure

Voice Rules.—Dialects differ so greatly that it is neither possible nor desirable to lay down too many rules governing pronunciation. The essential requirement is that words must be pronounced *clearly*, and in this connection the following “ don'ts ” must be borne in mind until you naturally acquire a good broadcasting voice.

Don't shout,	Don't talk too fast, and
Don't whisper,	Don't drawl.
Don't mumble,	

Use of Callsigns.—Callsigns are necessary because ships' names often sound very similar when spoken, and in certain circumstances it is undesirable to reveal the presence of specific ships. Every ship or station is therefore given a callsign which usually consists of one simple word not associated with any Service subject.

When a number of stations are working on the same frequency they are given a collective callsign in addition to their individual callsigns ; this enables the Senior Officer to control communications more easily. The Senior Officer may also have a special callsign in addition to his station callsign.

How Messages are Passed.—It is not possible here to give full details covering all circumstances, and full details of procedure are contained in the *Communication Instructions (Radio Telephone Procedure)*. A simple example is given below, however, which is intended to illustrate the general procedure to be followed for ensuring good communications.

A cruiser (Senior Officer) is carrying out a full-calibre shoot against a battle-practice target towed by a tug and “ marked ” by a destroyer. The callsigns used are :—

Senior Officer (cruiser)	<i>Keeper</i>
Collective (whole group)	<i>Trees</i>
Individuals :—(destroyer)	<i>Larch</i>
(tug)	<i>Lime</i>

The Senior Officer has a message for *Larch* and *Lime* :—

Trees – this is *Keeper* (message for you) – over.

(*Keeper*) – this is *Larch* (send your message) – over.

(*Keeper*) – this is *Lime* (send your message) – over.

(*Trees*) – this is *Keeper* – routine – time zero seven fower two – commence run one at zero ate wun fiyiv – over.

(*Keeper*) – this is *Larch* – roger – out.

(*Keeper*) – this is *Lime* – roger – out.

The short dashes (–) indicate a slight pause between the parts of each transmission. This is important because in most cases the person receiving has to write down the gist of the message using the abbreviations given earlier in this section.

The message above would be recorded in the destroyer (*Larch*) as follows :—

TR DE KE (MF) K
(KE) DE LA (SYM) K
(TR) DE KE – R – TMO742 – Commence run at 0815 K
DE LA R +

If bad conditions make communication difficult “ words twice ” procedure is used, in which case callsigns, phrases and text would be transmitted as follows :—

Trees Trees – this is *Keeper Keeper* – words twice – words twice – routine – routine – time – zero seven fower two – time – zero seven fower two – commence run one at – commence run one at – zero ate wun fiyiv – zero ate wun fiyiv – over – over.

Keeper Keeper – this is *Larch Larch* – roger – roger – out – out, etc.

Flashing Procedure

SPECIAL SIGNS

The following special signs are used in conjunction with the morse code.

UNKNOWN CALL	AA	Is the “ Unknown ship ” call, used to call a ship by flashing whose identity or callsign is unknown.
• – • –		
ENDING	AR	Is the “ End of transmission ” sign, used when no receipt is required.
• – • – •		
ENDING	K	If a receipt is required, which is always the case in normal procedure, the ending “ K ” is used instead of AR.
– • –		
RECEIPT	R	Means “ Message received ”.
• – •		
FULLSTOP	AAA	A punctuation mark in plain language ; written thus :—⊙
• – • – • –		
ERROR	EEEE	Means : <i>erase the portion of the message just transmitted ; the corrected portion will follow ; or, if followed by the Message Ending : erase the whole of this message, which is cancelled.</i>
• • • • • (eight or more)		
REPEAT	IMI	Made alone means : <i>repeat the last message.</i> Followed by DTG means : <i>repeat message timed</i> Followed by letters, AA, AB or WA, means : <i>Repeat the section indicated</i> (All After), (All Before), or (Word After). It precedes the second transmission when the whole or portion of a message is transmitted twice through.
• • – • – • •		

ALL SHIP CALL • • — — —	2,2,2,2	The Call, by flashing, for all ships and stations. An all-round light must be used for this purpose.
WAIT • — • • •	$\overline{AS}$	Used when a temporary break in communication is necessary. If to indicate a prolonged delay, it is followed by $\overline{AR}$.
INTERROGATIVE • • — • —	$\overline{INT}$	Means : <i>group which follows is to be read in an Interrogatory sense, i.e., it asks a question.</i>
EXECUTE TO FOLLOW • • — • • —	$\overline{IX}$	Means : <i>the signal is to be carried into execution on the termination of the 5-seconds flash or sound which follows.</i>
EXECUTIVE SIGNAL ———(5 seconds)	$\overline{IX}$	Means : <i>execute the signal previously received.</i>
PENNANT • — — • —	$\overline{PT}$	In the text only means : <i>numbers which follow are to be read as numbered pennants which form part of visual callsigns.</i>
STROKE — • • — •	$\overline{XE}$	Used when an oblique stroke or "slant" occurs in the text. Written thus : /
LONG BREAK — • • • —	$\overline{BT}$	Precedes and follows the "text" portion of a message. Written thus : =
SEPARATIVE • • • •	$\overline{II}$	Used between portions of a transmission when necessary to ensure that they are read as separate portions. Written thus : -

PROCEDURE MEANINGS

FM	Originator.	K	Go on. Transmit. Also the normal "End of Transmission" sign.
B	More to follow.	R	Received.
C	You are correct.	T	Transmit to.
F	Do not answer.	DE	From.
G	Repeat back.	INFO	Information Addressees.
J	Verify and Repeat.		

PROCEDURE METHODS

There are two principal flashing procedures :—

Non-directional, which is used when signalling with an all-round lantern to two or more stations.

Directional, which is used when signalling to one station only, irrespective of the type of lantern employed.

For signalling to one station only, a directional lantern should be used if possible.

A good knowledge of directional procedure is required of a seaman, and the following examples should be sufficient to enable him to transmit and receive a simple message.

With a directional lantern or projector, dispersion of the light is only a few degrees, and it must be remembered therefore that accurate aiming is essential, otherwise the beam will get off the exact bearing and bad communication will result. Should reception become difficult owing to a badly aimed or poor light, the receiving station should flash "W" continuously, whereupon the sender must direct a steady light until "K", meaning "Proceed", is received.

Should the transmitting station's light be too bright or large the receiving operator should flash "D" continuously until the brilliancy is reduced or a smaller light is used. When satisfied the receiving station will direct the transmitting station to proceed by flashing "K".

EXAMPLE.—*Daring* (callsign D p0 p5) has the following message for *Diadem* (callsign C p8 p4) : "Am anchored in B2 berth".

(DIRECTIONAL PROCEDURE) MESSAGE IN P/L.

MESSAGE PORTION	<i>Daring</i> (transmitting stn.)	<i>Diadem</i> (receiving stn.)	REMARKS
CALL ...	... C 8 4, C 8 4, C 8 4, etc.	K	In this message the call is also the Address.
	de	flash	
	D 0 5	flash	
LONG BREAK	<u>BT</u>	<u>AS</u>	Temporary delay.
	Flash		
	<u>BT</u>	K	When ready to proceed.
		flash	Long break indicates commencement (or end) of the text.
TEXT ...	Am	flash	
	anchored		Word "anchored" missed.
	anchored	flash	
	in	flash	
	Baker	flash	Phonetic Alphabet used for important letter.
	two	flash	Important number spelt out.
	berth	flash	
LONG BREAK	<u>BT</u>	flash	
	1624Z	flash	Time at which message was originated.
	K	R	"R" made after checking that message is correctly received.

Note.—When a message consists of coded groups the phonetic alphabet is to be used and a flash given for each word. A break sign is to be used to separate each group if any confusion would arise if omitted.

Semaphore Procedure

The following special signs are used in conjunction with the Semaphore Code.

<i>Special Signs</i>	<i>Prosigs</i>
<u>AAA</u> Fullstop.	<u>FM</u> . Originator.
<u>BT</u> Long Break.	<u>B</u> More to follow.
<u>KK</u> Parenthesis.	<u>T</u> Transmit to.
<u>XE</u> Stroke.	<u>DE</u> From.
<u>IMI</u> Repeat.	<u>INFO</u> Information.
<u>II</u> Separative.	<u>XMT</u> Exempt

To Call a Ship.—When one ship wishes to call another for the purpose of passing a signal by semaphore she usually hoists the other ship's visual flag callsign above *Jig* (the semaphore flag).

For a general message to all ships, however, *Jig* is hoisted singly and calls all ships and stations.

When flags are not suitable or not available the "call" for a single ship or station may be made by "directional light", until answered in the normal manner, followed by the word SEM, *e.g.* :—

<i>Transmitter</i>	<i>Receiver</i>
C18 C18 (etc.)	K
SEM	Flash

Whichever call is used semaphore flags are displayed at the same time as the "Direction" sign (J). This sign may be used as the call by itself for close working, or by arrangement to suit local conditions.

To Conduct a Message.—The receiving station hoists *Answer* at the dip as soon as the call is observed, and close up when ready to read and write down. It must *not* be hoisted close up until ready in all respects, otherwise the first part of the message will be missed. The receiving ship may hoist the transmitting station's callsign above *Answer* if being called by more than one station.

In harbour, with a large number of ships present, special flags are usually allocated for answering certain ships.

In a boat, or any other place where it cannot be hoisted, *Answer* is held in a horizontal position to indicate at the dip, and in a vertical position to indicate close-up. A semaphore hand flag or any conspicuous object may be used in the same manner.

The different parts of the message are signalled in the same sequence as by flashing. If no address is used, the message is understood to have been originated by the transmitting station and to be addressed to the receiving station.

In the following example a full address is used. This particular transmission is to *Daring* (callsign D p0 p5) from *Wizard*.

Wizard hoists D p0 p5 J by flags and at the same time shows the Direction sign by semaphore hand flags. When *Daring* answers close up *Wizard* proceeds :—FM D p7 p2 - to D p0 p5 - info C p3 p7 = My one two one eight - AAA - Boat will be provided by *Dido* = one six two four K.

Daring then hauls down *Answer* and *Wizard* hauls down *Call*.

Note.—A dash - represents the Separative sign II.

To Correct Mistakes During Transmission.—Should a word or portion of a message be incorrectly made, the transmitting ship will make the Error sign

(EEEE), then the last word or portion correctly made, and then proceed with the remainder of the message.

Portion Missed During Reception.—If a word or portion of a message is missed the receiving station must allow the transmitting station to complete the transmission of the message before requesting a repetition.

More than One Message for Transmission.—The transmitting station makes the More to Follow sign (B) before the Ending (K), then the Direction sign, and then proceeds with the next message in the normal manner, taking care to observe that the receiving station is still "close up".

ORIGINATING AND DRAFTING MESSAGES

The officer or other responsible person authorising a message to be sent is known as the "originator". He is responsible that it is worded and written down correctly and authorised by his initials and short title.

Before a message can be authorised, it must satisfy the following requirements :—

- that it is essential to the addressee ; and
- that communication by letter would not be equally effective.

When preparing a message the following principles and rules must be observed to ensure that it will be correctly handled by the operators and clearly understood by the addressee.

- (i) *Text must be brief and clear.*—Messages must be as brief as possible, consistent with clearness. Such terms as "Beg to report", "Sir", and "Please inform me" are usually superfluous and should be omitted.
- (ii) *Standard abbreviations and symbols should be used.*—Authorised abbreviations are provided for the more common titles, and should be used where applicable. A list of the more common abbreviations will be found at the end of this chapter. Unauthorised abbreviations must not be used. The common symbols for comma, degrees, minutes, seconds, measurements, decimal point, etc., are *NOT* permitted, the words must be written out in full.

The fullstop may be marked by the symbol $\odot$, or written out in full. To avoid mistakes :—

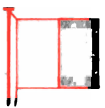
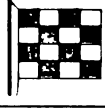
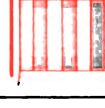
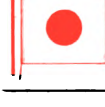
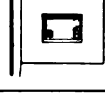
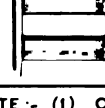
- the letter O (for Oboe) is written as O ;
- the figure 0 (for Zero) is written as θ ;
- the letter I (for Item) is written as i ;
- the figure 1 is written as l.

Important single letters should be written phonetically, *e.g.* "Station A", should be written as "Station Able"; but this must *NOT* be done when writing the initials of a person's name, owing to the risk of misinterpretation.

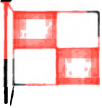
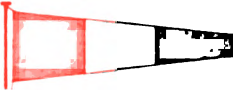
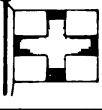
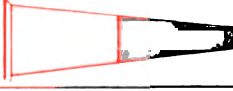
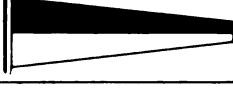
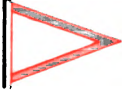
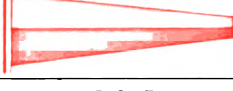
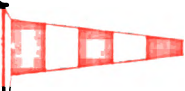
Numbers should be written out fully in words, *e.g.*, one seven for 17, except where exact hundreds or thousands occur, when they may be written as "one hundred", "five thousand", etc.

Proper names and difficult or unusual words should be written in BLOCK CAPITALS.

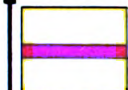
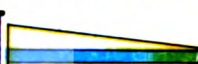
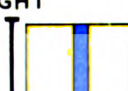
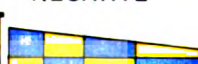
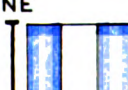
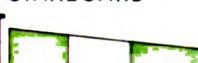
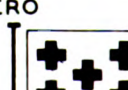
SIGNAL FLAGS
OF THE
NAVAL AND
INTERNATIONAL CODES
AND
THE STAR MAP

NAVAL AND INTERNATIONAL CODES ALPHABETICAL FLAGS			
A 	I AM UNDERGOING A SPEED TRIAL	K 	* YOU SHOULD STOP YOUR VESSEL INSTANTLY
B 	I AM TAKING IN OR DISCHARGING EXPLOSIVES	L 	* YOU SHOULD STOP — I HAVE SOMETHING IMPORTANT TO COMMUNICATE
C 	YES (AFFIRMATIVE)	M 	I HAVE A DOCTOR ON BOARD
D 	KEEP CLEAR OF ME — I AM MANOEUVRING WITH DIFFICULTY	N 	NO (NEGATIVE)
E 	I AM DIRECTING MY COURSE TO STARBOARD	O 	* MAN OVERBOARD
F 	* I AM DISABLED — COMMUNICATE WITH ME	P 	IN HARBOUR :- * ALL PERSONS ARE TO REPAIR ON BOARD AS THE VESSEL IS ABOUT TO PROCEED TO SEA . AT SEA - *YOUR LIGHTS ARE OUT OR BURNING BADLY .
G 	I REQUIRE A PILOT	Q 	MY VESSEL IS HEALTHY, AND I REQUIRE FREE PRATIQUE
H 	I HAVE A PILOT ON BOARD	R 	* THE WAY IS OFF MY SHIP — YOU MAY FEEL YOUR WAY PAST ME
I 	I AM DIRECTING MY COURSE TO PORT	S 	MY ENGINES ARE GOING FULL SPEED ASTERN
J 	I AM GOING TO SEND A MESSAGE BY SEMAPHORE	T 	DO NOT PASS AHEAD OF ME

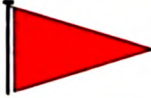
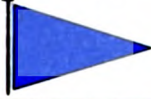
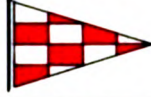
NOTE:- (1) ONLY THOSE LETTERS AND MEANINGS MARKED * MAY BE INDICATED BY THE MORSE CODE, EITHER BY SOUND OR BY FLASHING.
(2) ONLY THE INTERNATIONAL MEANINGS ARE GIVEN TO LETTERS.

NAVAL AND INTERNATIONAL CODES (CONTINUED)			USED ON ALL OCCASIONS WHEN IT IS REQUIRED TO REPRESENT NUMBERS IN FLAG SIGNALLING.
ALPHABETICAL FLAGS AND SUBSTITUTES		NUMBERED PENNANTS	
U 	* YOU ARE STANDING INTO DANGER	ONE 	
V 	* I REQUIRE ASSISTANCE	TWO 	
	* I REQUIRE MEDICAL ASSISTANCE	THREE 	
X 	STOP CARRYING OUT INTENTIONS AND WATCH FOR MY SIGNALS	FOUR 	
Y 	I AM CARRYING MAILS	FIVE 	
Z 	* TO BE USED TO ADDRESS OR CALL SHORE STATIONS	SIX 	
1 ST SUBSTITUTE 	USED TO REPEAT THE FIRST FLAG OR PENNANT IN THE SAME HOIST.	SEVEN 	
2 ND SUBSTITUTE 	USED TO REPEAT THE SECOND FLAG OR PENNANT IN THE SAME HOIST	EIGHT 	
3 RD SUBSTITUTE 	USED TO REPEAT THE THIRD FLAG OR PENNANT IN THE SAME HOIST	NINE 	
CODE AND ANSWER 	USED TO ACKNOWLEDGE A SIGNAL. ALSO FLOWN BY A WARSHIP WHEN MAKING A FLAG SIGNAL FROM THE INTERNATIONAL CODE TO DISTINGUISH IT FROM THE NAVAL CODE	ZERO 	

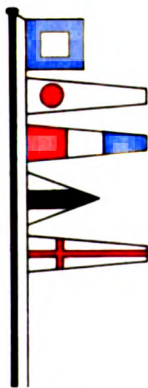
NOTE :- (1) ONLY THOSE LETTERS AND MEANINGS MARKED * MAY BE INDICATED BY THE MORSE CODE, EITHER BY SOUND OR BY FLASHING.
(2) ONLY THE INTERNATIONAL MEANINGS ARE GIVEN TO LETTERS.

OTHER FLAGS AND PENNANTS USED IN NAVAL SIGNALLING			
NUMERAL FLAGS		PENNANTS	
ONE		INTERROGATIVE	
TWO		ANSWER AND CODE	
THREE		COURSE (CORPEN)	
FOUR		CHURCH	
FIVE		FORM	
SIX		PREPARATIVE	
SEVEN		DESIG (ALPHABETICAL / NUMERAL)	
EIGHT		NEGATIVE	
NINE		STARBOARD	
ZERO		TURN	

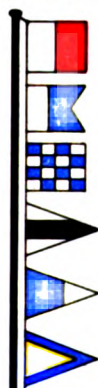
OTHER FLAGS AND PENNANTS USED IN NAVAL SIGNALLING
(CONTINUED)

SQUADRON 		SPEED 	
FLOTILLA 		STATION 	
DIVISION 		SUB-DIV. 	
PORT 		EMERGENCY 	
		4 TH SUBSTITUTE 	
 RED FLAG		BLACK PENNANT 	

USE OF SUBSTITUTES



P 1338



HANNAH



151551

THE FIRST SUBSTITUTE REPEATS THE UPPER FLAG OR PENNANT OF A HOIST. THE SECOND SUBSTITUTE REPEATS THE SECOND FLAG OR PENNANT, AND SO ON.





Reproduced by kind permission of G. C. Flower Esq. and Messrs. Henry Hughes and Son Ltd.

THE STAR MAP (Key overleaf)

KEY TO PLATE 5 — THE STAR MAP

STAR GROUPS

I		II		III	
PLOUGH.....	1, 2, 3, 4, 5 etc.	RIGHT ANGLE.....	10, 11, 12	COCKED HAT.....	20, 21 etc.
POLAR POINTERS.....	2, 1	POLAR POINTERS.....	12, 11	POLAR POINTERS.....	21, 20
TAIL.....	5, 6 etc.	LANTERN (ORION).....	13, 14, 15 etc.	ADJACENT NEIGHBOURS.....	22, 23
WEDGE.....	7 etc.	HORNS.....	16, 18, 19 etc.	THE "W".....	24 etc.
SICKLE.....	8 etc.			PURSE.....	25, 26 etc.
SWALLOW TAIL.....	9 etc.			SQUARE.....	28, 29 etc.
North of Equator.....				DIAMOND.....	30 etc.
South of Equator.....					

I		II		III	
SCEPTRE.....	31, 32, 33 etc.	KITE.....	40, 41, 42 etc.	FANTAIL.....	46, 47, 48 etc.
HEAD.....	"Southern Cross"	POLAR POINTERS.....	41, 40	BUG.....	49 etc.
POLAR POINTERS.....	32, 31	TAIL.....	43, 44 etc.		
SOUTHERN POINTERS.....	34, 35				
SCORPION.....	36, 37 etc.				
BOOK.....	38 etc.				
TRIANGLE.....	39 etc.				

PRINCIPAL STARS

I		II		III	
1.....	DUBHE	10.....	CAPELLA	20.....	DENEB
5.....	ARCTURUS	13.....	RIGEL	22.....	VEGA
6.....	SPICA	15.....	BETELGEUSE	23.....	ALTAIR
8.....	REGULUS	16.....	ALDEBARAN	28.....	ALPHERATZ
		17.....	SIRIUS		
		18.....	PROCYON		
		19.....	POLLUX		
North of Equator.....					
South of Equator.....					
I		II		III	
31.....	ACRUX	40.....	M.P. DUS	46.....	FOMALHAUT
33.....	RI. KENT	45.....	CANOPUS	47.....	ACHERNAR
36.....	ANTARES			48.....	PEACOCK

- (iii) *The correct "Precedence Indicator" must be used.* A "precedence indicator" is always to be used to ensure that a message is handled according to its importance and degree of urgency.

If precedence is misused it may allow less important messages to hold back important ones.

These indicators with their respective prosigns are given in the table below.

PROSIGN	PRECEDENCE INDICATOR	USE
OC	FLASH	Confined strictly to use with short messages of vital tactical importance: such as reports of initial contact with the enemy.
O	EMERGENCY	Used for subsequent reports of first contact with the enemy, for messages of the utmost urgency affecting national security, distress and warning of severe storms likely to endanger shipping.
OP	OPERATIONAL IMMEDIATE	Used for certain enemy reports where a higher precedence is not justified. For administrative messages, delay in whose delivery will adversely affect current operations. For certain aircraft movement reports.
P	PRIORITY	Used with messages which must be handled before routine traffic. Administrative messages must not normally be graded higher than priority.
R	ROUTINE	Messages which must be delivered to the addressee without delay but are not sufficiently urgent to justify a higher precedence.
NM	DEFERRED	Originators are to mark messages Deferred if a delay in receipt by the addressee of up to 36 hours can be accepted.

- (iv) *Every message must be classified for security, i.e., TOP SECRET, SECRET, CONFIDENTIAL, RESTRICTED, OR UNCLASSIFIED, according to the nature of the text.* The above classifications, with the exception of Unclassified, can be given additional security by use of the prefix "NODECO". This reduces to a minimum the number of persons who will see the message, and is used extensively for messages concerning the private affairs of officers and ratings.

The following is a specimen of a message correctly drafted on a Naval message form :—

PRECEDENCE—ACTION <i>Priority</i>	PRECEDENCE—INFO <i>Routine</i> ~~DEFERRED~~	DATE—TIME GROUP <i>122027Z</i>	MESSAGE INSTRUCTIONS <i>(Filled in by communication dept.)</i>
FROM <i>D 4</i>			PREFIX GR
TO <i>DARING</i>			SECURITY CLASSIFICATION <i>Unclassified</i>
INFO <i>CAPT I/C PORTLAND</i>			ORIGINATORS NUMBER <i>(Not applicable to R.N.)</i>

My 121408. Proceed to position Able as soon as Major

FLINT is onboard comma reporting time of arrival to Capt I/C

Note.—The Communication department is responsible for inserting the Date Time Group and any details or instructions in the spaces above the heavy black line, such as the Prefix and the Group.

The Date Time Group provides a means of reference to a former message ; in the above example, "My 121408 " means, " With reference to my message bearing the Date Time Group 121408 ".

COMMUNICATION DEPARTMENT—ORGANISATION

The communications of a ship are under the control of a Signal Officer, or, if no such officer is borne, an officer appointed by the Captain to carry out this duty.

The department comprises Signal and Telegraphist ratings, whose responsibilities are defined below.

Signal Ratings

The Chief Yeoman of Signals, or senior signal rating when no C.Y.S. is borne, is responsible to the Signal Officer for the watch and duty organisation of the signal staff. He also attends on the Captain, both at sea and in harbour.

The yeoman of the watch, whatever his substantive rating, is in charge of the signal watch on deck.

The leading hand of the watch keeps his watch on the compass platform at sea, and is directly responsible for keeping the Officer of the Watch fully informed of all signals which concern him. The remainder of the watch are employed on the flag or other signal deck, as required.

The Main Signal Office (M.S.O.) is the focal point through which all messages pass, except those classified as Top Secret, Secret and Nodeco, irrespective of the signal system employed. Any enquiries regarding messages generally should therefore be addressed to the M.S.O.

All messages for transmission, except those classified as Top Secret, Secret and Nodeco, must first be sent to the M.S.O., but manœuvring and certain other signals originated on the bridge at sea are transmitted direct by the appropriate method.



Fig. 318. A signal office

Telegraphist Ratings

The Chief Petty Officer Telegraphist, or senior telegraphist rating when no C.P.O. Tel. is borne, is responsible to the Signal Officer for the watch and duty organisation of the telegraphist staff.

The petty officer telegraphist of the watch (P.O.O.W.), whatever his substantive rating, is in charge of the wireless watch.

The remainder of the watch are employed as operators on the wave frequencies ordered to be manned, and as otherwise required.

Cleaning and minor repair and adjustment of wireless equipment are carried out by telegraphist ratings as detailed.

Major defects and refitting and servicing are dealt with by the Electrical department.

General

The Cryptographic Office is usually in the charge of a senior communication rating; the cryptographic staff are provided from signal and telegraphist ratings, as ordered by the Signal Officer. Voice-operators are also provided from signal or telegraphist staffs, as most convenient.

MESSAGE HANDLING AND DISTRIBUTION

The Communication department is responsible for the transmission, reception, internal handling, and recording and filing of messages. It is also responsible for their distribution to heads of departments, and to such other officers as are required to take early action on a message. The departments concerned carry out any further distribution necessary to personnel within their departments.

Messages of an Urgent Nature.—The warning telephone system is available, at the discretion of the Officer of the Watch, for circulating urgent information, and much valuable time can often be saved by its use. For example, the message "Set anchor watch, raise steam for slow speed to ensure safety" is received. This will immediately be reported by the Communication department to the Commanding Officer, Officer of the Watch, Duty Engineer Officer and Navigating Officer, by messenger or internal telephone, whichever is the quicker. The O.O.W. would either direct the message to be broadcast by the Wa/T system, or broadcast the necessary orders for anchor watch to be set.

Non-urgent Messages.—The Main Signal Office decides the distribution required, and circulates the message by messenger. Heads of departments, and offices, affected by the message are provided with copies.

Messenger Duty.—Ratings are detailed from the Watch and Station Bill for duty as M.S.O. messengers; the complement of Communication ratings does not provide for this duty, and they should therefore not be used for it under normal circumstances.

Filing of Messages.—When all necessary action has been taken on a message it is filed in a special retainer which must contain a record of all messages received and transmitted. Messages are entered in their correct sequence so that they are quickly available for further reference if required.

All enquiries concerning the handling, contents, or disposal of messages should be made to the M.S.O.

AUTHORISED ABBREVIATIONS

(i) The following list gives the more common abbreviations used in signalling. A more complete list is contained in the relevant signalling instructions.

A.A.	Anti-aircraft	Capt. I/C	Captain-in-Charge
A.C.H.Q.	Area Combined Headquarters	C.B.	Confidential Book
Admty	Admiralty	C.D.	Captain of Dockyard
A.F.O.	Admiralty Fleet Order	Cdr.	Commander
A.G.M.	Admiralty General Message	Cdre.	Commodore
A.I.C.	Action Information Centre	C. in C.	Commander-in-Chief
A.L.	Admiralty Letter	C.O.	Commanding Officer
A.M.	Admiralty Message	C.O.F.	Captain of the Fleet
A.O.C.	Air Officer Commanding	C.O.S.	Chief of Staff
A.S.	Admiral Superintendent	C.S.	Captain Superintendent
A/S	Anti-submarine	C.S.O.	Chief Staff Officer
		C.Y.O.	Cryptographic Officer
B.C.O.	Base Communication Officer	D (No :)	Captain (D) (No :)
B.E.O.	Base Engineer Officer		Destroyer Flotilla
B.N.L.O.	British Naval Liaison Officer	(No:)D.F.	(No:) Destroyer Flotilla (e.g. 3rd : D.F.)
B.P.F.	British Pacific Fleet	D.C.H.Q.	Damage Control Headquarters
B.P.T.	Battle Practice Target	D.E.M.S.	Defensively Equipped Merchant Ship
B.R.	Book of Reference		
B.W.O.	Bridge Wireless Office		

D/F	Direction Finding	O.C.R.M.	Officer Commanding Royal Marines
D/R	Despatch Rider	O.N.	Official Number
D.S.B.	Duty Steam or Power Boat	O.O.D.	Officer of the Day
E.G.(No:)	Senior Officer (No:) Escort Group	O.O.G.	Officer of the Guard
(No:)E.G.	(No:) Escort Group (<i>e.g.</i> 10th E.G.)	O.O.P.	Officer of Patrol
E.O.	Engineer Officer	O.O.W.	Officer of the Watch
F.L.	Flag Lieutenant	O.U.	Official Use
F.C.	Flag Captain	P.C.O.	Principal Control Officer
F.O.C.	Flag Officer Commanding	P/G	Postagram
F.O.I.C.	Flag Officer-in-Charge	P/L	Plain Language
F.O.S/M	Flag Officer, Submarines	P/V	Paravane
G.H.Q.	General Headquarters	P.W.S.S.	Port War Signal Station
G.M.T.	Greenwich Mean Time	R.A.	Rear-Admiral
G.O.	Gunnery Officer	R.N.A.S.	Royal Naval Air Station
H/F	High Frequency	R.N.B.	Royal Naval Barracks
H.F.	Home Fleet	R.N.H.	Royal Naval Hospital
Info	Information	R.N.R.	Royal Naval Reserve
K.H.M.	King's Harbour Master	R.N.V.R.	Royal Naval Volunteer Reserve
Kc/s	Kilocycles per second	R.T.O.	Railway Transport Officer
Lt.	Lieutenant	S.A.R.	Search and Rescue
Lt. Cdr.	Lieutenant-Commander	S.B.N.O.	Senior British Naval Officer
M.A.A.	Master-at-Arms	S.C.O.	Staff Communication Officer
Mc/s	Megacycles per second	S.G.B.	Steam Gun Boat
M/F	Medium Frequency	S/M	Submarine
Mid.	Midshipman	S.N.O.	Senior Naval Officer
M.O.	Medical Officer	S.P.	Signal Publication
M.O.G.	Medical Officer of the Guard	S/S	Sound Signalling
M.S.	Minesweeper	S.S/T	Super Sonic Telegraphy
M.S.(No:)	Senior Officer (No:) Mine-sweeping Flotilla	S/T	Sonic Telegraphy
(No:)MSF	(No:) Minesweeping Flotilla	T.O.	Torpedo Officer or Transport Officer
M.S.O.	Main Signal Office	T.O.D.	Time of Despatch
M.T.B.	Motor Torpedo Boat	T.O.R.	Time of Receipt
N.A.S.	Naval Air Station	T/P	Teleprinter
N.L.O.	Naval Liaison Officer	T.S.S.	Two Speed Sweep
N.O.	Navigating Officer	V.A.	Vice-Admiral
N.O.I/C	Naval Officer-in-Charge	V.H/F	Very High Frequency
N.P.M.	Naval Provost Marshal	V.L/F	Very Low Frequency
N.S.O.	Naval Store Officer	V.S.	Visual Signalling
		Wa/T	Warning Telephone
		W/T	Wireless Telegraphy
		W.T.	Watertight

(ii) The following are the more common "plain language" (P/L) abbreviations for use in the text of a message.

PSB	Please Send Boat.
WSB	Will Send Boat now (or at time indicated).
ICU	can I come and See You now (or at time indicated).
UCM	can You come and See Me now (or at time indicated).
RPC	Request the Pleasure of your Company at . . .
WMP	With Much Pleasure.
MRU	Much Regret I am Unable to . . .
VMT	Very Many Thanks.
OSC	Open and Signal Contents of telegram for
RGa	Request Ground Allocation (for sport event, date and time as indicated).
RAG	Requested Allocation Granted.
GNA	regret Ground Not Available.

CHAPTER XVII

Ceremonial

MOST ceremonies are an expression of respect, courtesy, rejoicing, or sorrow, and so their form varies and must also be adapted to suit local circumstances. Ceremonial plays an important part in the life of a sailor of the Royal Navy, and he must therefore have a good knowledge of its naval forms, and of the customs and traditions upon which these are founded.

Nothing in this chapter should be read as specifically authorising any particular procedure or conduct, and where any doubt as to the correct procedure may arise the regulations contained in the *Queen's Regulations and Admiralty Instructions* should always be consulted and obeyed.

When interpreting the regulations it should be borne in mind that offence may be given by not according some recognised mark of respect, and on the other hand marks of respect will be depreciated if they are used indiscriminately in the interests of flattery or ingratiation ; the only way to avoid both is strictly to observe the regulations.

Wearing of Colours

Strictly speaking, a suit of colours worn by any of H.M. ships in commission comprises the White Ensign, the Union Flag flown as a jack, and the masthead pennant, but if the ship is a flagship the distinguishing flag of her flag officer replaces this pennant. In general, however, the term "colours" is understood to mean the ensign and jack only.

Particular care must always be taken to ensure that these colours are hoisted close up and not foul of the mast, staff, or rigging ; also that the halyards are taut and the lacing set up correctly. The manner in which a ship wears her colours is an indication of her smartness.

The ensign and jack are flown during the prescribed hours by all H.M. ships at anchor, secured to a buoy, or berthed alongside ; but when the ship gets under way (*i.e.*, when the last anchor is aweigh, the slip-rope slipped from the buoy, or the last hawser let go), the jack is lowered, and it is not rehoisted until the ship again anchors, secures to a buoy, or berths alongside (*i.e.*, until the first anchor is let go, the picking-up rope brought to the capstan, or the first hawser secured).

There are, however, certain exceptions to these rules. A ship under way in harbour wears her ensign whenever there is sufficient light for it to be seen. A ship at anchor in harbour may hoist her ensign at times other than during the prescribed hours to disclose her nationality or identity to a ship entering or leaving harbour, or to acknowledge the salute of a passing merchant ship. The only two occasions when a jack is worn by one of H.M. ships under way are : when she is under way in a harbour and ships not under way are dressed overall ; and when she is wearing the Royal Standard or escorting a ship in which the Sovereign is embarked. For reasons of economy the jack is not worn by ships in dock, or by ships undergoing a dockyard refit.

Ensigns are half-masted to indicate a death. They are usually half-masted on the day of the funeral only, from the time the body leaves the ship or place

where it has been lying to the time when it is buried. When the ensign is ordered to be half-masted throughout the day it is first hoisted close up at "Colours" and then lowered to half-mast, and at sunset it is first hoisted close up from half-mast and then lowered.

The following notes on the ceremony attending the hoisting of colours in harbour are given as a general guide :—

- (i) The Officer of the Watch should report personally to the Captain five minutes before the time of "Colours".
- (ii) If foreign warships are in company the band plays the national anthems of their countries after ours and in the order of the seniority of their flag officers, or in an order varied from day to day.
- (iii) When in a foreign port the national anthem of the country of that port is played immediately after our national anthem.
- (iv) The "Carry on" is not sounded until the full ceremony is over, and all hands on deck (other than those on the quarterdeck) remain at the salute until the "Carry on" is sounded. All hands on the quarterdeck come to the salute as the guard executes the last motion of the "Present arms", and returns from the salute with the last motion of the "Slope arms" or "Shoulder arms".
- (v) If a band is not paraded the bugler sounds the "General salute" in place of the national anthem.
- (vi) If a bugler is not available the "Still" is piped on the boatswain's call by the quartermaster of the watch at the appointed time; the colours are hoisted in silence, and the "Carry on" is piped on completion. When in company the time of piping the "Carry on" is taken from the Senior Officer present.
- (vii) Guards and bands are not usually paraded for "Colours" on Saturdays and general drill days.

Dressing Ship

Ships are dressed overall in harbour at the same time as the colours are hoisted. If under way at the time of "Colours" a ship is dressed as soon as she anchors or berths alongside. Before dressing ship the whips are manned and the down-hauls tended, and men are stationed aloft to guide the dressing lines and flags clear of any obstructions. When the "Preparative flag" is hauled down the "G" is sounded on the bugle, and at this signal the lines are triced into position simultaneously and then set up taut by means of tackles on deck. The ceremony of "Colours" is carried out immediately after the lines are triced up. When rigging the lines they are rove on the lee side (if the ship is not heading into the wind) to allow the flags to blow clear of the superstructure as they are triced up.

Ships in harbour dress overall with flags from "Colours" to sunset on the following occasions :—

- (i) anniversaries of the dates of the accession and coronation of the Sovereign;
- (ii) anniversaries of the dates of the birth of Their Majesties;
- (iii) on Empire Day (24th May);

- (iv) by order of the Senior Officer present, on the occasions of visits of royal personages, or on certain foreign ceremonial occasions.

Ships under way in port, or ships not fitted for dressing overall, dress with ensigns at the mastheads, and at the same time hoist the Union Flag at the jackstaff.

Wearing of Distinguishing Flags

When a Flag Officer or a Commodore hoists his flag or broad pennant in a ship, that ship is known as the flagship of his particular command. The distinguishing flag of a personage other than a Flag Officer or a Commodore may, with the approval of the Senior Naval Officer of the station, be worn by one of H.M. ships when the personage is embarked in her on the public service within the limits of the former's command or authority.

In home waters, on the day when a Flag Officer relinquishes his command, his flag and that of his successor are each hoisted in different ships or establishments and remain flying during the day of transfer of the command.

A Flag Officer's flag is only struck in the following circumstances :—

- (i) when he relinquishes his command ;
- (ii) when the Royal Standard or the Admiralty Flag is worn ;
- (iii) if he is absent through sickness or is in hospital ;
- (iv) if he is absent on leave for a period exceeding 48 hours (on home service only) ;
- (v) if he dies.

On the death of a Flag Officer his flag is half-masted from the time he dies until sunset on the day of his funeral, when his flag is first hoisted close-up and then finally struck.

Should a Flag Officer be killed in battle, his flag is not half-masted until the action is finally ended.

These remarks on the wearing of Flag Officer's flags apply also to the wearing of the broad pennants of Commodores.

In the days of three-masted ships an Admiral wore his flag at the main, a Vice-Admiral at the fore, and a Rear-Admiral at the mizzen. Nowadays, with two-masted ships, it is the custom to reserve the main masthead for the flag of an Admiral-of-the-Fleet, an Admiral, or a Commander-in-Chief, other Flag Officers wearing their flags at the fore masthead.

An Admiral-of-the-Fleet wears the Union Flag at the main masthead as his proper flag.

In destroyers and similar ships the principal mast is the foremast, the after-mast being known as the mizzenmast. In these ships flags of rank are hoisted at the foremast, the mizzenmast being reserved for the ensign when it is not worn at the ensign staff.

Flag and Senior Officers' Distinguishing Lights

In peace-time, both in harbour and at sea (except when steaming without lights), the flagship or the ship of the Senior Officer of a squadron or flotilla is distinguished by a white top-light, showing abaft the beam and usually displayed at the maintop. In harbour, in addition to the top-light, a flagship is distinguished by one, two or three all-round white lights denoting, respectively, a Rear-Admiral, Vice-Admiral, and an Admiral or Admiral-of-the-Fleet.

These lights are usually displayed athwartships on the poop or after super-structure, below the top-light and clear of the normal stern light.

Other ships (*i.e.*, "private ships") may often be distinguished from each other at night by a cluster of lights representing their names or their initial letters, displayed at the gangway.

Piping the Side

Except for foreign naval officers, for whom the side is piped at all times, the side is only piped to the following persons, and only between the times of "Colours" and sunset :—

- (i) the Sovereign when in uniform ;
- (ii) members of the Royal Family of the rank of Captain and above when in naval uniform ;
- (iii) members of the Board of Admiralty when acting as a Board, and naval members of the Board when in uniform ;
- (iv) all executive officers of the rank of Admiral-of-the-Fleet, Admiral, Vice-Admiral, and Rear-Admiral in uniform ;
- (v) Commodores in uniform who are authorised to wear a broad pennant ;
- (vi) all naval executive officers in uniform holding an appointment to command a ship, a sea-going tender, or a naval shore establishment (such officers coming on board by a brow should not be piped unless arriving at a pre-arranged time) ;
- (vii) naval members of a court martial attending or leaving the court ;
- (viii) the Officer of the Guard when flying his pennant ;

Notes.—(i) *All officers of the Royal Navy in uniform, irrespective of branch, are piped aboard foreign warships.*

(ii) It is customary to pipe the side when a corpse is embarked or disembarked.

The side is piped when the officer arrives and again when he leaves. It is piped twice on each occasion—once when his boat approaches or leaves the gangway and again as he ascends or descends the accommodation ladder. When an officer arrives or departs by a brow he is piped once only, as he crosses the brow.

Gun Salutes and Firing of Guns

The regulations for gun-salutes are laid down in the *King's Regulations and Admiralty Instructions*. The more general occasions on which gun-salutes are fired are :—

- (i) anniversaries of the coronation and accession of the Sovereign, and the birthdays of Their Majesties ;
- (ii) at visits by the Sovereign or members of the Royal Family to ports or to H.M. fleets or ships ;
- (iii) when H.M. ships meet with the Sovereign or with any member of the Royal Family at sea ;
- (iv) on occasions similar to those in (ii) and (iii), but in regard to the heads of foreign states ;
- (v) on the arrival of one of H.M. ships at a foreign port, in honour of the country concerned ;

- (vi) on arrival of one of H.M. ships at a foreign port, in honour of the foreign Flag Officer-in-Charge (if any) ;
- (vii) when any of H.M. ships meets a foreign Flag Officer at sea (unless H.M. ship is wearing the flag of an officer senior to him) ;
- (viii) when any of H.M. ships is visited by, or meets with at sea, the Board of Admiralty, or the First Lord of the Admiralty ;
- (ix) by the next senior officer present when a Flag Officer hoists his flag on assuming command ;
- (x) by a ship, or by the senior of two or more ships, when first meeting a Flag Officer at sea or in harbour after the latter has assumed his command ;
- (xi) when H.M. ships are visited on official occasions by British or foreign personages, or by Military or Air Force officers who are entitled to a salute ;
- (xii) at the funerals of high-ranking officers.

It used to be the custom when at sea for the saluting ship to turn and head towards the ship being saluted. This originated in the days when ships were armed with broadside guns only and the salutes were fired with shotted rounds ; by heading towards the other ship the salute could not be mistaken for an act of aggression. This custom, however, is not observed nowadays.

Royal and national salutes are of 21 guns. The number of guns for other salutes varies from 19 (*e.g.*, for the Board of Admiralty) to 7 (*e.g.*, for a Consul). A salute to a national flag, or to the flag of a foreign Flag Officer, is returned gun for gun. A salute by one of H.M. ships to the flag of a British Flag Officer is returned by the number of guns to which the officer initiating the salute is entitled ; although officers of the rank of Captain and Commander are not entitled to a gun salute, they are in this respect entitled to a return-salute of 7 guns. No other gun salutes are returned.

On occasions of visits to ships by royalty, heads of states, the Board of Admiralty, naval boards of British commonwealths, and the Army and Air Councils, salutes are fired when they go on board and again when they leave the ship. Salutes to personages other than those mentioned above are fired once only, either when they go on board or when they leave the ship.

SALUTES AT FUNERALS

Minute-guns are fired at the funeral of an officer entitled to a gun-salute, between the time his body leaves the ship or place where it has been lying and the time it is buried ; in the case of royalty the guns are fired at three-minute intervals. A salute is also fired after the burial, and in each case the number of guns is limited to that to which the officer was entitled when alive.

At the funeral of a Captain or Commander in command of a ship seven minute-guns and a salute of seven guns are allowed.

At the funeral of all officers and men three volleys of musketry are fired over the grave (or over the body when committed to the sea) and the " Last Post " is sounded.

Only ships commanded by a Captain or Commander, and equipped for saluting, are authorised to fire salutes.

TIMES OF FIRING SALUTES

The general rule is that salutes shall be fired only between 0800 and sunset, except on Sundays when they shall be fired only between 0800 and 1030, and

EXAMPLES OF MILITARY HONOURS AND MARKS OF RESPECT

PERSONAGE			GUNS	ALERT	GUARD	MUSICAL SALUTE	PIPE
Governors-General	...	...	19	Yes	Captain's	First 6 bars of National Anthem	No
Prime Ministers	...	...	None	Yes	None	None	No
Ambassadors, when in uniform	...	...	19	Yes	None	None	No
Governors, High Commissioners, certain Lieutenant-Governors, when in uniform	...	...	17	Yes	Captain's	"Garb of Old Gaul"	No
Other Lieutenant-Governors, Commissioners, Administrators, Residents, Diplomatic or Consular Officers, etc., who are entitled to a salute of 11 guns or more; when in uniform	...	...	15 to 11	Yes	None	None	No
Board of Admiralty when acting as a Board	...	...	19	Yes	Captain's	"Rule Britannia"	Yes
Admirals of the Fleet	...	...	19				
First Lord of the Admiralty	...	...	17				
Admirals	...	...	17	Yes	Captain's	"Iolanthe"	Yes
Other Flag Officers or Commodores holding appointments as Commanders-in-Chief	...	...	15 to 11				
Vice-Admirals	...	...	15				
Lieutenant-General in command of a station	...	...	13	Yes	Subaltern's	"Iolanthe"	Yes
Rear-Admirals	...	...	11				
Commodores entitled to fly a broad pennant	...	...	None				
A Rear-Admiral holding a staff appointment	...	...	None	Yes	None	None	Yes
A Commodore holding a staff appointment	...	...	None	Yes	None	None	No
Officers of non-executive branches of the equivalent rank of Rear-Admiral or above	...	...	None	Yes	None	None	No
Captains R.N., when flying their pennants	...	...	None	No	Sergeant's	None	Yes
Brigadier not holding an appointment in command of a Station	...	...	None	Yes	None	None	No
Group Captain in command of a Royal Air Force Station...	...	...	None	No	Sergeant's	None	No

- Notes :
- (i) A Captain's guard consists of a captain, 2 N.C.O.s, 48 men and a bugler.
 - (ii) A Subaltern's guard consists of a subaltern, 2 N.C.O.s, 48 men and a bugler.
 - (iii) A Sergeant's guard consists of a sergeant and 20 men.

1300 and sunset. Noon on weekdays is the time laid down for firing salutes in honour of royal anniversaries.

FLAG HOISTED DURING GUN SALUTES

For royal salutes and salutes to national flags the appropriate standard or flag is broken at the main masthead. For other personal salutes the appropriate flag is broken at the fore masthead. The standard or flag is broken with the first gun of the salute and hauled down immediately after the last gun.

LOGGING SALUTES

All gun salutes and official ceremonies are entered in the ship's log and in a separate saluting log which is kept by the signalmen.

MORNING AND EVENING GUN

In British ports at home and abroad the senior Flag Officer or Commodore present may order a morning or evening gun to be fired. In home waters the morning gun is fired at daybreak, and the evening gun is fired at 2100 from 25th March to 20th September inclusive, and at 2000 from 21st September to 24th March inclusive. Abroad the times of firing are directed by the Commander-in-Chief of the station.

It is laid down that whenever the morning and evening guns are fired the sentries of other ships present are to discharge their rifles in a volley, and that immediately after the morning gun is fired all ships are to sound the reveille, and that for 15 minutes before the evening gun is fired the tattoo is to be sounded. The firing of morning and evening guns with their associated ceremonies is now, however, rarely carried out.

COURT MARTIAL GUN

In a ship in which a court martial is to be held a gun is fired, and the Union Flag is hoisted at the peak, at the time of "Colours" on each day on which the court sits. The Union Flag is hauled down when the court adjourns for the day or disperses, and when more than one court martial is held on the same day it is dipped between each separate court.

Military Honours

These include the parading of guards and bands, and as a rule these honours are only paid, in part or in whole, to dignitaries who are entitled to a salute of 11 guns or more (that is to certain dignitaries of and above the equivalent rank of a Commodore or a Brigadier).

No military honours are paid to civilians or church dignitaries, except to diplomatic agents of the Pope who, as Head of the Papal State, is regarded as a foreign sovereign.

For officers of the Royal Navy, military honours are only accorded to Flag Officers, Commodores entitled to wear a broad pendant, and executive officers of the rank of Captain who are in command of ships or shore establishments.

The table on page 550 is neither authoritative nor entirely comprehensive, but it indicates the general distinctions in the according of military honours and marks of respect.

GUARDS

Guards are only paraded for royalty, foreign sovereigns and heads of states, and persons holding military rank (*i.e.*, those in command of the armed forces

of a country). They are known as "Guards of Honour" and vary in size with the importance of the person for whom they are paraded. A Royal Guard consists of a major, a subaltern, four N.C.O.s, 96 men and one bugler.

BANDS

Musical salutes are only accorded to those persons who are entitled to be received by a guard. The playing of musical salutes appears to be of comparatively recent origin, especially if the selection of tunes is taken as an indication of the age of the custom. In 1841 the customary salute to officers of high rank on board H.M. ships was the beating of drums; for an Admiral or Commander-in-Chief the drums beat a march, for a Vice-Admiral they beat three ruffles, for a Rear-Admiral two ruffles, and for a Commodore one ruffle.

Their Majesties are saluted with the National Anthem. Other members of the Royal Family and certain Governors-General are saluted with the first six bars of the National Anthem.

Foreign sovereigns and presidents of republics are saluted with the national anthems of their respective countries.

Other officers or dignitaries are saluted by the playing of specified tunes.

HOURS DURING WHICH GUARDS AND BANDS ARE PARADED IN HARBOUR

Weekdays: from "Colours" to noon (except Saturdays), and from 1315 to sunset or 1800, whichever is the earlier; or, when a two-hour dinner hour is in force, from 1400 to sunset or 1800, whichever is the earlier.

Sundays: from "Colours" to 1200 (except during divine service).

Exceptions: (i) guards and bands are not paraded from one-and-a-half hours before carrying out general drill until one hour after general drill is completed.

(ii) When proceeding into or out of harbour, or when passing or being passed by a royal or other personage in a ship or boat, or when receiving such personages on board, guards and bands are paraded at any time from "Colours" to sunset (or 1800) on *weekdays*, and from "Colours" to noon on *Sundays*.

NOTES ON MILITARY HONOURS

- (i) A guard and band are only paraded for a Flag Officer or a Commodore when he is wearing his flag or broad pennant.
- (ii) An officer of flag-rank not entitled to wear a flag, or a Commodore not entitled to wear a broad pennant, does not receive a gun salute, nor is he received with a guard and band unless he is a member of the Board of Admiralty, but the "Alert" should be sounded. If he is an officer of flag-rank the side should be piped.
- (iii) A naval member of the Board of Admiralty in uniform is accorded the full military honours and marks of respect appropriate to his rank.
- (iv) An administrative officer (*e.g.* a Governor), if he is also an officer of flag-rank, is entitled to the full military honours and marks of respect appropriate to his naval rank if he is in naval uniform. If he holds other military rank he is entitled to the military honours of that rank.
- (v) Army and Air Force officers of and above the rank of Brigadier and Air Commodore are entitled to the same military honours as their equivalent ranks in the Royal Navy if they hold military command.

- (vi) If no band is available for receiving a Flag Officer the " General Salute " is sounded on the bugle instead of the appropriate musical salute, and similarly the " Commodore's Salute " is sounded for a Commodore.
- (vii) Captains and Commanders in command of ships are entitled to a return salute of seven guns.
- (viii) Captains and Commanders when attending as members of a court martial are entitled to be received by a sergeant's guard, but the guard only presents arms to the President of the Court.
- (ix) Foreign officers of military, diplomatic, or administrative services receive the same honours as their equivalents in British services.
- (x) At the discretion of the Senior Officer, other distinguished persons may be received with the " Alert ".

Ceremonial Reception

The following description of the ceremonial attending the reception of personages on board one of H.M. ships is given as a general guide.

Fifteen minutes before the expected time of arrival, " Guard and band " and " All buglers " are sounded, and the Ceremonial Piping Party is piped to muster. (When appropriate this party should comprise the Boatswain, Chief Boatswain's Mate, Chief Quartermaster, and all available quartermasters, boatswain's mates and side-boys.)

If a gun salute is to be fired, " Saluting guns' crews " is sounded ; the Gunner is informed of the number of guns for the salute, and the Chief Yeoman of Signals is told what flag is to be broken at the masthead with the first gun. The " Commence " is sounded on the bugle as the signal for the first gun to be fired.

As soon as the boat conveying the personage is sighted, or known to be on its way, the Captain and the Executive Officer are informed, the quarterdeck is cleared, and the side is manned.

At the order " Man the side " the Ceremonial Piping Party is mustered in two or three ranks athwartships and just before the gangway. Two side-boys man the lower platform of the accommodation ladder to hand the manropes and assist the personage and his retinue out of the boat, and one side-boy, stationed before the piping party, mans the boat-rope. The Officer of the Watch supervises proceedings from the upper platform of the accommodation ladder until the personage has left his boat. The guard is drawn up fore-and-aft, abaft the gangway, clear of the side and facing outboard ; and the band is drawn up abaft, and in line with, the guard.

When the boat is two or three lengths from the accommodation ladder the " Alert " is sounded and the guard comes to the " Slope " (or the " Shoulder " if awnings are spread). This is followed by the first pipe if the personage is entitled to one. The second pipe is begun when the personage sets foot on the lower platform of the accommodation ladder, and ends as he reaches the upper platform. Any accompanying retinue do not leave the boat until the personage has been received on board. All members of the reception party come to the salute during each pipe. As soon as the personage steps aboard, the guard comes to the " Present " and the band plays the appropriate musical salute, after which the guard returns to the " Slope " (or " Shoulder ") and the members of the reception party return from the salute. The officer commanding the guard then reports his guard to the personage if he is of senior relative

rank to the officer receiving him, and the personage may then inspect the guard ; if, however, the personage is of junior relative rank to the officer receiving him, the guard is not reported to him, nor does he inspect it. If a salute is to be fired it can be fired immediately before the personage arrives if his time of arrival has been arranged beforehand, or immediately after his boat has left the ship. The " Commence " is sounded before the gun salute, the " Cease fire " after it, and after a suitable pause the " Carry on " is sounded.

The ceremonial on leaving is very similar, and is carried out in the order : " Guard and band ", " Man the side " (any accompanying retinue proceed into the boat), " Alert ", " Present arms " (reception party come to the salute) " Musical salute ", " Slope " (or " Shoulder ") arms", " First pipe " (if accorded), " Second pipe " (starting as the boat leaves the accommodation ladder), reception party return from the salute. If a gun salute is to be fired the " Commence " is sounded when the boat is lying off clear of the line of fire. The " Carry on " is not sounded until the boat clears either the stem or stern of the ship on her return trip.

Between the sounding of the " Alert " and the " Carry on ", all hands on deck stand to attention and face outboard and boats under way stop engines or toss or lay on their oars, or let fly sheets, according to the type of boat.

Salutes between Ships

When a ship enters or leaves harbour between sunrise and sunset all hands on deck should be dressed in the correct rig and fallen in, all boats (except sea-boats) should be turned in, guns correctly trained and laid, the ship's sides clear, and ropes and rigging neatly stowed and secured. Between " Colours " and sunset or 1800 (whichever is the earlier) the lower deck is cleared, the ship's company is mustered at stations for entering and leaving harbour, and guards and bands are paraded.

When two warships pass one another between sunrise and sunset the following salutes are exchanged :—

- (a) *When only one ship is under way, and when either ship is wearing a royal standard, flag, or broad pennant, or when the other ship is a foreign man-of-war.*

The junior ship sounds the " Alert " on the bugle, which is answered by the senior ship sounding the " Alert " on the bugle. All the ship's company on deck in both ships come to attention and face outboard, and the senior officer on board the junior ship salutes, this salute being returned by the officer being saluted in the senior ship. If the occasion is one on which guards and bands parade, the guard of the junior ship presents arms and her band plays the appropriate musical salute. Such military honours are received with the guard of the senior ship at the slope. After a short interval the senior ship sounds by bugle the " Carry on ", this being followed by the junior ship also sounding the " Carry on ".

Notes.—(i) If a bugle is not available the " Still " is piped on the boatswain's call, or blown on a whistle, instead of the " Alert " being sounded.

- (ii) If a band is not available the " General Salute " is sounded on the bugle in place of any musical salute. If a bugle is not available the salute is given in silence.

- (iii) Whenever the bugle is available it is used in giving or returning the salute.
- (iv) When the other ship is a foreign man-of-war and doubt arises as to which is the senior ship, His Majesty's ship should be ready to initiate the exchange of salutes.

(b) *When only one ship is under way, and when neither ship is wearing a royal standard, flag, or broad pennant, and when the other ship is not a foreign man-of-war.*

The bugle is not used, but similar marks of respect are accorded and returned by pipe or blown on the whistle. If guards and/or bands are paraded the guards remain at the slope and no musical salutes are accorded.

Note.—The “Alert” sounded on the bugle is a mark of respect due to rank, and is accorded only to those persons so entitled.

(c) *In all cases when both ships are under way.*

The salute is made and returned by pipe, or blown on the whistle; bugles are not sounded. If guards are paraded they come to the slope only, and if bands are paraded no musical salutes are accorded.

Note.—If the other ship is a foreign man-of-war and appears likely to sound the “Alert” and accord other military honours, reciprocal action should be taken by H.M. ships.

Ceremonial in Boats

WEARING OF ENSIGNS IN BOATS

Boats belonging to H.M. ships or establishments wear ensigns on the following occasions when under way :—

- (i) between “Colours” and sunset whenever wearing a Royal Standard or a distinguishing flag of an authority other than a naval authority;
- (ii) in foreign waters on all occasions during daylight hours;
- (iii) whenever going alongside a foreign warship, by day or night;
- (iv) whenever H.M. ships are dressed;
- (v) whenever carrying a corpse, the ensign being then worn at half-mast.

Note.—When the ensign is half-masted in H.M. ships, boats ensigns (if worn) should also be half-masted.

WEARING OF DISTINGUISHING FLAGS OR PENNANTS IN BOATS

Any of the persons authorised to wear a distinguishing flag or pennant may wear the appropriate flag (or pennant) in the bows of a boat when under way and proceeding on occasions of ceremony, such as official visits or inspections. If the person is other than a naval authority the boat also wears her ensign. Persons other than naval authorities only wear their flags in boats between the hours of “Colours” and sunset. Although not specifically laid down, the flags of naval authorities are usually flown in boats during the hours of daylight only.

The masthead pennant is worn in a boat, under similar circumstances, by executive commissioned officers holding an appointment in command of one of H.M. ships, sea-going tenders, or shore establishments.

The masthead pendant is also flown in a boat between the hours of “Colours” and sunset if she is carrying members of a court martial who are proceeding

to or from the court. It is also worn by day and by night by a boat carrying the Officer of the Guard.

A King's Harbour Master or his deputy may wear his flag in the bows of a boat or vessel when in the execution of his duty.

The Admiralty Flag is worn by a boat only when she is carrying members of the Board of Admiralty who are acting as a Board. If a boat carries the First Lord, or naval members of the Board when not acting as a board, the "Admiralty flag plate" (as described below) is displayed.

Officers of flag rank usually have their flags painted on the bows of their barges instead of the boat's badge. Their barges can be distinguished by the colour of the hull—green for Commanders-in-Chief and dark blue for other Flag Officers.

The boats of Chiefs-of-Staff or Captains-of-the-Fleet have the flag appropriate to the Flag Officer on whose staff they are serving painted on the bows.

DISPLAYING OF INDICATOR PLATES IN BOATS

"Indicator plates" are displayed in boats on occasions when a distinguishing flag is not worn to denote the presence of senior officers.

The following are the authorised indicator plates used for this purpose :—

- (i) the "Admiralty flag plate", 12 inches long and 6 inches broad, similar to the Admiralty flag in colour and design ;
- (ii) the "Red disc", consisting of a white St. George's cross on a red background ;
- (iii) the "Blue disc", consisting of a white St. George's cross on a blue background ;
- (iv) the "White disc", consisting of five black crosses on a white background.

(All discs are 10 inches in diameter.)

The Admiralty flag plate denotes that the boat is carrying on a formal occasion the First Lord of the Admiralty, or a naval member or members of the Board of Admiralty when not acting as a board. On such occasions the full ceremonial due to the rank of the personage in the boat is to be accorded.

The Red disc denotes that the boat is carrying any of the following personages on a formal occasion, but that the full ceremonial due to their rank is not required :—

- (i) the First Lord of the Admiralty ;
- (ii) A naval member or members of the Board of Admiralty in uniform ;
- (iii) Flag Officers in uniform ;
- (iv) Commodores in uniform who are entitled to fly a broad pennant.

The Blue disc denotes that the boat is carrying on a formal occasion a non-executive officer of the equivalent rank of Rear-Admiral or above, or a Commodore not entitled to fly a broad pennant. On such occasions the officer is received with the "Alert".

The White disc denotes that the boat is carrying any of the above named personages on an informal occasion when only courtesy salutes are accorded.

SALUTING OF STANDARDS AND DISTINGUISHING FLAGS WORN BY BOATS

When a boat wearing a standard or a distinguishing flag, or displaying the Admiralty flag plate, passes a ship at anchor, the ship should parade a

guard and a band and accord the appropriate salute unless orders to the contrary have been issued.

Should the ship, however, be wearing the flag or broad pendant of an officer senior to the officer in the boat, the guard and band are not paraded and the "Alert" only is sounded. (This rule does not apply when the officer in the boat is a naval member of the Board of Admiralty.)

If the boat passes a ship under way the ship should pipe the "Still", and if her guard and band are paraded the guard should come to the "Slope" and no musical salute should be accorded.

When a boat displaying the Red or the Blue disc passes a ship at anchor the ship should sound the "Alert" only. A ship under way should pipe the "Still".

When a boat displaying the white disc passes a ship at anchor, the Officer of the Watch (or in his absence the quartermaster) should salute from the gangway.

SALUTES AND MARKS OF RESPECT IN BOATS

All officers when getting into or leaving a boat are saluted by the officer in charge of the boat or the coxswain.

The following rules govern the exchange of salutes between Service boats under way :—

- (i) the officer or coxswain in charge of the boat will always salute, except that when he is in an inconspicuous position one of the boat's crew will be detailed to salute instead ;
- (ii) the senior of the officers in the boat will also salute whenever this is practicable ;
- (iii) the salute will be acknowledged by the officer being saluted, unless he details an officer or the coxswain to do so ;
- (iv) no salutes are exchanged between boats carrying officers of equal rank.

In boats other than Service boats, whether alongside or underway, officers and men should pay and return salutes as dictated by courtesy, but only the officer or man in the most convenient position should salute.

In addition to these salutes, special marks of respect are paid to royal and important personages and senior officers, as shown in the table on page 558.

BOAT HAILS

At night, any boat approaching within hailing distance of a ship is challenged by the hail "Boat ahoy". If the boat is not calling alongside the hailing ship she will reply "Passing". If the boat is to call alongside, her reply will be governed by the rank or status of the persons she is carrying, in accordance with the following table :—

<i>Person carried</i>	<i>Reply</i>
A Royal Personage or Head of a State	"Standard".
A member of the Board of Admiralty	"Admiralty".
A Flag Officer, or a Commodore entitled to fly his broad pennant.	"Flag", followed by the name of his flagship when appropriate.
A Chief-of-Staff, Chief Staff Officer, or a Captain-of-the-Fleet.	"Staff" with the name of the flagship.

TABLE OF SPECIAL MARKS OF RESPECT TO BE PAID IN BOATS

PERSONAGE TO WHOM, OR OCCASION ON WHICH, MARKS OF RESPECT SHOULD BE PAID	MARKS OF RESPECT BY BOATS UNDER WAY			MARKS OF RESPECT BY A BOAT ALONGSIDE A LANDING PLACE, AN ACCOMMODATION LADDER, OR MADE FAST
	POWER BOAT	BOAT UNDER OARS	BOAT UNDER SAIL	
(i) The Sovereign ; members of the Royal Family and equivalent personages of other nations ; Ambassadors, Governors-General, and their equivalents in other nations ; (Standard or appropriate flag is worn by the boat)		Double-banked boats <i>Toss Oars</i>		
(ii) Members of the Board of Admiralty when acting as a Board ; the First Lord of the Admiralty and naval members of the Board of Admiralty when the Admiralty flag plate is displayed ; Commanders-in-Chief, Flag Officers and Commodores, and their equivalents in other Services and nations, when wearing the appropriate flag of their command in their barges or boats	<i>Stop Engines</i>	Single-banked boats <i>Lay on Oars</i>	<i>Let-fly Sheets</i>	Crew called to attention (see notes (ii), (iii), (iv) and (v) below).
(iii) A boat containing a Service funeral party with the body ; (ensign at half mast is worn by the boat)				
(iv) During the hoisting and lowering of colours in harbour, and during the firing of gun salutes				
(v) The First Lord of the Admiralty, naval members of the Board of Admiralty, Commanders-in-Chief, Flag Officers, Commodores, non-executive officers of the rank of Rear-Admiral and above, and officers or personages of equivalent rank in other Services or nations ; when displaying a red or a blue disc in the boat	Reduce speed to <i>Slow</i>	All types of boats <i>Lay on Oars</i>	<i>Let-fly Sheets</i>	Crew called to attention (see notes (ii), (iii), (iv) and (v) below).
(vi) Commanders-in-Chief, Flag Officers, Commodores, and officers of equivalent rank in uniform or plain clothes ; when displaying a white disc in the boat				
(vii) Any British or foreign naval officer wearing a pennant in a boat				

- Notes**
- (i) Marks of respect are paid in all boats on occasions (iii) and (iv) above. Otherwise only in boats in which officers junior to the personage or officer passing are passengers.
 - (ii) In decked-in power boats, members of the crew who are not engaged in keeping the boat alongside, and all passengers, stand to attention and face in the direction of the personage or officer being saluted.
 - (iii) In open boats of all types, members who are not engaged in keeping the boat alongside and all passengers, sit at attention.
 - (iv) Boatkeepers sit at attention and the senior rating in the boat salutes.
 - (v) The executive order for calling the crew and passengers of a boat to attention is "Boat's crew". The customary attitude of attention when seated in a boat is sitting upright and squarely on the thwart or bench, with arms folded.
 - (vi) It is the custom in the Royal Navy for a boat to avoid crossing close ahead of any boat which is carrying an important personage or a senior officer, even if the former boat has right of way by the Rule of the Road.

Commanding Officer of a ship	... ..	Name of the ship which he commands.
Other officers of and above the rank of Lieutenant.		" Aye, aye ".
Officer of the Guard	... ..	" Guard boat ".
All other persons and all boats going alongside not otherwise provided for.		" No, No ".

Wearing of Standards or Flags in Vehicles

If a vehicle conveys a royal or other personage on ceremonial or official occasions the appropriate standard or flag, in miniature, may be worn on the front of the vehicle, and the salute necessary to the occasion should be accorded.

CHAPTER XVIII

Rule of the Road*

EXPLANATION OF THE INTERNATIONAL REGULATIONS FOR PREVENTING COLLISIONS AT SEA (1910)

THESE regulations were formulated, and agreed to by the leading maritime nations, in the early years of this century, and were incorporated in International Law when they were finally ratified by the nations concerned in 1910.

In 1929 the 1910 Regulations were revised by the International Conference for the Safety of Life at Sea, which was held in London. The 1929 regulations, however, were never fully ratified by the nations concerned, and therefore did not become a part of International Law; the 1910 regulations are therefore still (1950) in force. The seaman will find, however, that many of the 1929 amendments have been put into effect in various parts of the world, and some of them are therefore included in this chapter, but where they are mentioned they are annotated to differentiate them from the 1910 regulations.

Another International Conference on the Safety of Life at Sea was held in London, in 1948, at which the 1929 regulations were revised, and at which it was decided to issue a new set of regulations to be called the International Regulations for Preventing Collisions at Sea, 1948. These differ in many respects from both the 1910 and the 1929 regulations, but because they have not yet (1950) been made a part of International Law, they are not included in this chapter.

The regulations consist of thirty-one articles, and, as well as being in the *King's Regulations and Admiralty Instructions*, they are set out fully in the *Admiralty Navigational Manual* and in Volume III of this manual. They are enforced in all British vessels other than H.M. ships by the *Merchant Shipping Act*, and in H.M. ships by the *King's Regulations and Admiralty Instructions*.

In this chapter, which is intended to introduce the seaman to "The Rule of the Road" both at sea and in harbour, and to explain to him its principles, only the more important articles have been included to avoid confusing him with too many minor details.

SCOPE OF THE REGULATIONS

The regulations should be obeyed by all vessels on the high seas. They are also applicable in territorial waters and in waters connected with the open sea which are navigable by sea-going ships; in such waters where manœuvring space is limited and vessels must of necessity pass close to one another, in

* Important

The Rule of the Road at Sea as described in this Chapter is that which is at present (1950) in force, and conforms to the *Regulations for Preventing Collisions at Sea*, 1910. At the time of going to press, however, it is understood that new regulations, to be called *The Regulations for Preventing Collisions at Sea*, 1948, may be ratified by international agreement in the near future and, if so, they will be put into effect one year after the date of ratification.

A substitute chapter which conforms to the 1948 Regulations has therefore been prepared and has been incorporated in this volume as Appendix IV. If and when the 1948 Regulations are put into effect this chapter should be cancelled, and Appendix IV, at the back of the book, should be used instead.

channels, harbours and rivers for example, they may be qualified by local regulations.

The thirty-one articles are divisible into two distinct parts, one dealing with "Steering and Sailing Rules", and the other with lights, daymarks and sound signals.

The Steering and Sailing Rules provide for almost all occasions of two vessels approaching one another where risk of collision exists. They tell the seaman which vessel must give way, and describe the conditions under which he may expect the other vessel to keep clear of him.

The remaining articles prescribe the means whereby vessels which are fully manœuvrable may be identified by night or in low visibility; also the means whereby vessels with no power (or limited power) of manœuvrability may be distinguished, by day or by night, or in low visibility, from those which are fully manœuvrable. By these means (*i.e.* the display of lights and shapes and the making of sound signals) the seaman may know instantly whether to expect another vessel to obey the Steering and Sailing Rules or whether she is unable to do so. They also include sound signals to be made by vessels in various circumstances, signals to made by vessels in distress to attract attention or summon assistance, and precautions to be taken by all vessels.

ORDER IN WHICH THEY AND OTHER TRAFFIC REGULATIONS ARE DESCRIBED

In the first part of this chapter are described the principles upon which the Steering and Sailing Rules are based, and some definitions are given of the terms used. Then follow Articles 16 to 30 of the *International Regulations for Preventing Collisions at Sea*, reproduced word for word. These articles deal chiefly with the Steering and Sailing Rules and the sound signals to be made by vessels when obeying them; they are the most important articles of these regulations, and the seaman should know them thoroughly. At the end of the articles are given notes on their interpretations.

Next are described the navigation lights which should be displayed by vessels at night, with some general notes on navigation lights. Then follows a table of lights and daymarks to be displayed in certain circumstances by vessels, with notes on their interpretation.

Next are described the sound signals prescribed by the regulations to be made by vessels in conditions of low visibility. Then follow other sound signals which may be made by vessels, some of which are authorised by the *International Code of Flag Signals* and others by local harbour regulations.

At the end of the chapter are given signals authorised by the regulations to be displayed by vessels in distress, and finally are included some miscellaneous signals which may be met with at sea.

PRINCIPLES OF THE STEERING AND SAILING RULES

The rules for a steam vessel meeting another steam vessel depend upon the relative bearing between the two ships, and are quite separate from the rules for a sailing vessel meeting another sailing vessel, which are governed by the direction of the wind.

The main principles upon which the Steering Rules for steamships are based are that :—

- (i) when two vessels approach end on to one another, each must give way to the other ;
- (ii) in all other circumstances where risk of collision exists one vessel holds her course and speed while the other gives way ;

- (iii) the vessel which is directed to give way does so by altering course, or reducing speed, or stopping, or going astern ;
- (iv) the vessel which is directed to give way should avoid crossing close ahead of the other ;
- (v) in a broad sense vessels keep to the right ;
- (vi) vessels should always keep a proper lookout, exhibit the prescribed daymarks and lights, make the prescribed sound signals, and be handled in a seamanlike manner with due caution and consideration for others, especially in conditions of low visibility ;
- (vii) if a collision appears probable each vessel must take whatever action is possible to avert it, even if such action involves a departure from the normal rules.

The principle on which the Sailing Rules are based is that the vessel which would lose more ground by an alteration of course is given right of way, a vessel beating to windward for example.

Risk of Collision

When two vessels appear to be on converging courses the possibility of collision depends upon their relative courses and speeds. The course and speed of one vessel is difficult to judge from another, and the only certain way of determining whether risk of collision exists is to take a compass bearing of the

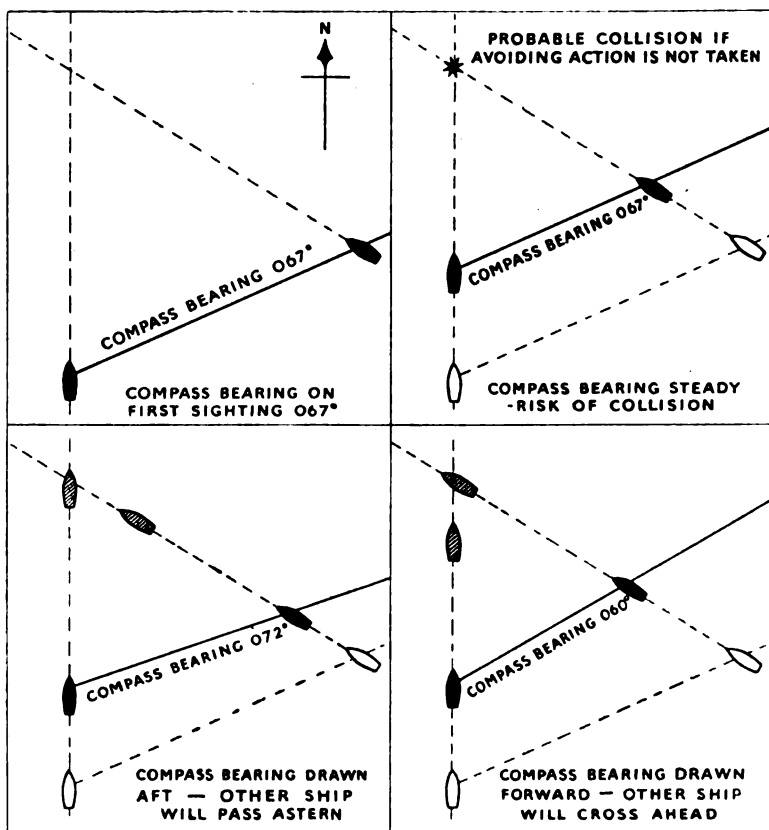


Fig. 319. Risk of collision

other vessel. If the bearing does not alter appreciably then risk of collision exists. If it "draws forward" the other vessel should cross ahead, and if it "draws aft" she should pass astern. If a compass is not available relative bearings may be taken, but it should be borne in mind that a relative bearing will alter if your vessel yaws to either side of her course, and due allowance should be made for this.

The Giving-way Vessel

To determine whether you should give way to another steam vessel, divide your horizon into three arcs relative to your course. You must give way to any steam vessel approaching from within the starboard arc, except to an overtaking vessel which has moved into that arc from the overtaking arc. You do not give way to any steam vessel approaching from within the port arc. All vessels approaching you from within the overtaking arc keep clear of you. It should be borne in mind that where risk of collision exists the vessel which has right of way must not alter course, or increase or reduce speed, except to avoid navigational dangers or to take avoiding action if a collision appears probable. A vessel's course is deemed to be the course which she is endeavouring to steer, and due allowance must be made by the giving-way vessel for any yawing caused by weather or other circumstances.

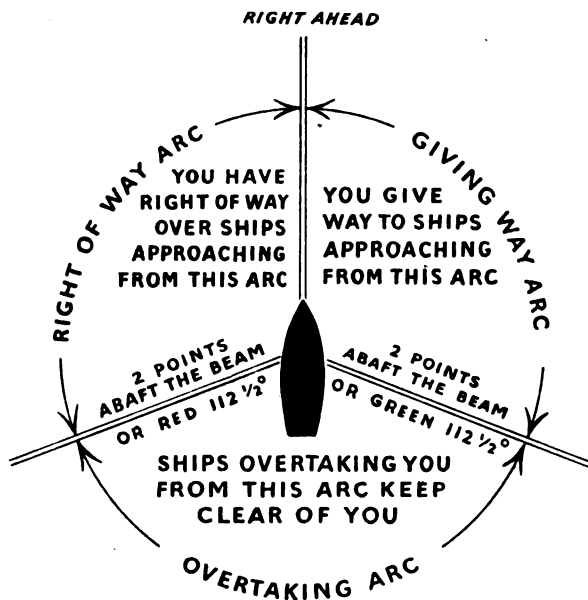


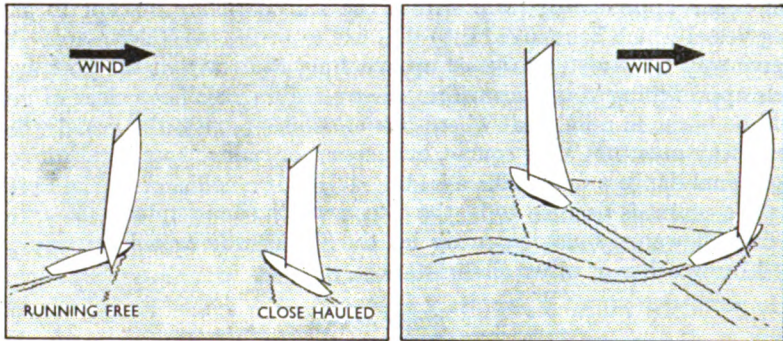
Fig. 320. Relative arcs

Definitions

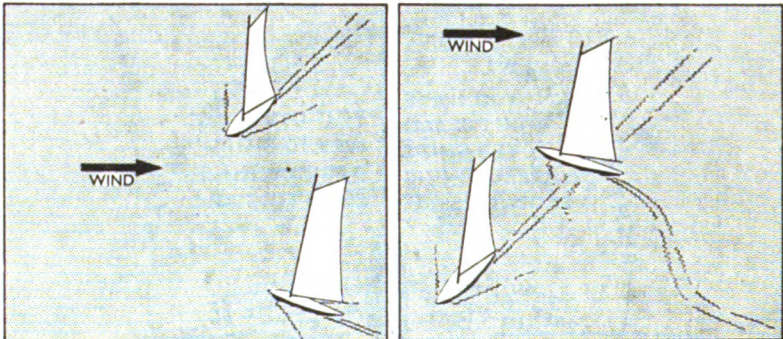
Before considering the Steering and Sailing Rules given on pages 565 to 569 the following definitions should be learned :—

- (i) The term steam vessel denotes any vessel which is mechanically propelled. It includes motor boats, diesel craft, and auxiliary craft (*i.e.* vessels which are propelled both by the wind and mechanical means).
- (ii) The term sailing vessel denotes any vessel which is propelled only by means of the wind and her sails.

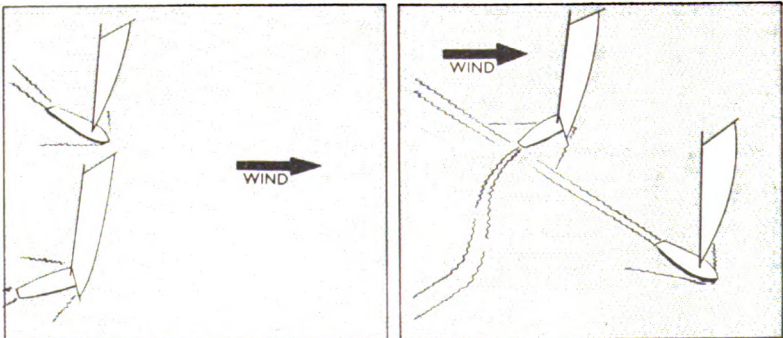
- (iii) A vessel is said to be "under way" when she is not at anchor, or made fast to the shore or the bottom, or aground. Thus a vessel may be described as "under way, but stopped", or "under way and making way". All vessels under way are bound to obey the Steering and Sailing Rules unless they are "not under command", *i.e.*, unless they are unable to manœuvre for any reason.



A SAILING VESSEL RUNNING FREE GIVES WAY TO ONE CLOSE HAULED.



TWO SAILING VESSELS CROSSING ON OPPOSITE TACKS.
THE VESSEL ON THE PORT TACK GIVES WAY.



TWO SAILING VESSELS, BOTH RUNNING FREE, WITH THE WIND ON OPPOSITE SIDES.
THE VESSEL WITH THE WIND ON HER PORT SIDE GIVES WAY.

Fig. 321. Examples of the Sailing Rules

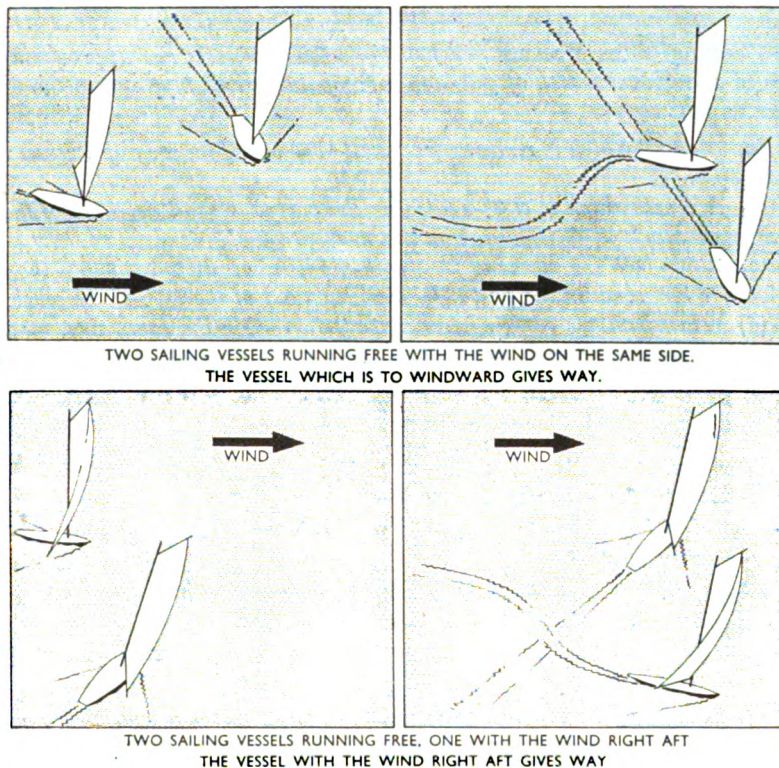


Fig. 321 (contd.) Examples of the Sailing Rules

EXTRACTS FROM THE "INTERNATIONAL REGULATIONS FOR PREVENTING COLLISIONS AT SEA" (1910)

(See Figs. 321 and 322)

ARTICLE 16

Speed of Ships to be Moderate in Fog, etc.

Every vessel shall, in a fog, mist, falling snow, or heavy rain storms, go at a moderate speed, having careful regard to the existing circumstances and conditions.

A steam vessel hearing, apparently forward of her beam, the fog-signal of a vessel the position of which is not ascertained, shall so far as the circumstances of the case admit, stop her engines, and then navigate with caution until danger of collision is over.*

Steering and Sailing Rules

Preliminary—Risk of Collision

Risk of collision can, when circumstances permit, be ascertained by carefully watching the compass bearing of an approaching vessel. If the bearing does not change appreciably such risk should be deemed to exist.

* The use of the expression "forward of" instead of the seamanlike expression "before" is probably because these regulations were finally drafted by lawyers and not by seamen. The seaman will find this unseamanlike term used again in Article 24.

ARTICLE 17

Two Sailing Ships Meeting. When two sailing vessels are approaching one another so as to involve risk of collision, one of them shall keep out of the way of the other as follows, viz :—

(a) A vessel which is running free shall keep out of the way of a vessel which is close-hauled.

(b) A vessel which is close-hauled on the port tack shall keep out of the way of a vessel which is close-hauled on the starboard tack.

(c) When both are running free, with the wind on different sides, the vessel which has the wind on the port side shall keep out of the way of the other.

(d) When both are running free, with the wind on the same side, the vessel which is to windward shall keep out of the way of the vessel which is to leeward.

(e) A vessel which has the wind aft shall keep out of the way of the other vessel.

ARTICLE 18

When two steam vessels are meeting end on, or nearly end on, so as to involve risk of collision, each shall alter her course to starboard, so that each may pass on the port side of the other.

This article only applies to cases where vessels are meeting end on, or nearly end on, in such a manner as to involve risk of collision, and does not apply to two vessels which must, if both keep on their respective courses, pass clear of each other.

The only cases to which it does apply are when each of the two vessels is end on, or nearly end on, to the other ; in other words, to cases in which, by day, each vessel sees the masts of the other in a line, or nearly in a line, with her own ; and, by night, to cases in which each vessel is in such a position as to see both the side-lights of the other.

It does not apply, by day, to cases in which a vessel sees another ahead crossing her own course ; or, by night, to cases where the red light of one vessel is opposed to the red light of the other, or where the green light of one vessel is opposed to the green light of the other, or where a red light without a green light, or a green light without a red light, is seen ahead, or where both green and red lights are seen anywhere but ahead.

ARTICLE 19

Two Steamships Crossing. When two steam vessels are crossing so as to involve risk of collision, the vessel which has the other on her own starboard side shall keep out of the way of the other.

ARTICLE 20

Steamship to keep out of way of Sailing Ship. When a steam vessel and sailing vessel are proceeding in such directions as to involve risk of collision, the steam vessel shall keep out of the way of the sailing vessel.

ARTICLE 21

Vessel not giving way to keep Course and Speed. Where by any of these rules one of two vessels is to keep out of the way, the other shall keep her course and speed.

Note : When, in consequence of thick weather or other causes, such vessel finds herself so close that collision cannot be avoided by the action of the giving-way vessel alone, she also shall take such action as will best aid to avert collision. (See Articles 27 and 29).

ARTICLE 22

Avoiding Crossing Ahead. Every vessel which is directed by these rules to keep out of the way of another vessel shall, if the circumstances of the case admit, avoid crossing ahead of the other.

ARTICLE 23

Steamship giving way to Slacken Speed. Every steam vessel which is directed by these rules to keep out of the way of another vessel shall, on approaching her, if necessary, slacken her speed, or stop, or reverse.

ARTICLE 24

Ships overtaking others. Notwithstanding anything contained in these rules, every vessel overtaking any other shall keep out of the way of the overtaken vessel.

Every vessel coming up with another vessel from any direction more than two points abaft her beam, i.e. in such a position with reference to the vessel which she is overtaking that at night she would be unable to see either of that vessel's sidelights, shall be deemed to be an overtaking vessel ; and no subsequent alteration of the bearing between the two vessels shall make the overtaking vessel a crossing vessel within the meaning of these rules, or relieve her of the duty of keeping clear of the overtaken vessel until she is finally past and clear.

As by day the overtaking vessel cannot always know with certainty whether she is forward of or abaft this direction from the other vessel, she should, if in doubt, assume that she is an overtaking vessel and keep out of the way.

ARTICLE 25

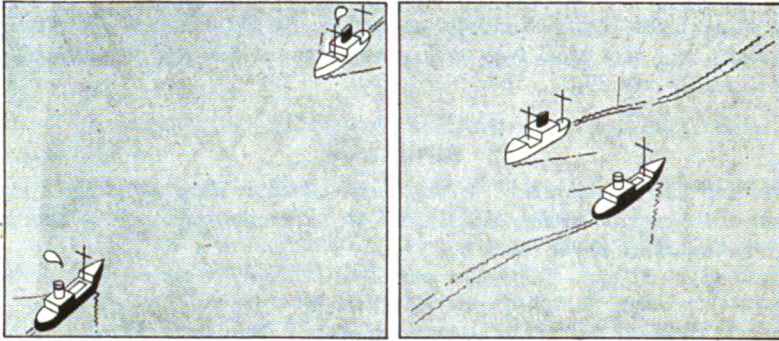
In Narrow Channels. In narrow channels every steam vessel shall, when it is safe and practicable, keep to that side of the fairway or mid-channel which lies on the starboard side of such vessel.

ARTICLE 26

Keeping clear of Fishing Boats. Sailing vessels under way shall keep out of the way of sailing vessels or boats fishing with nets, or lines, or trawls. This rule shall not give to any vessel or boat engaged in fishing the right of obstructing a fairway used by vessels other than fishing vessels or boats.

ARTICLE 27

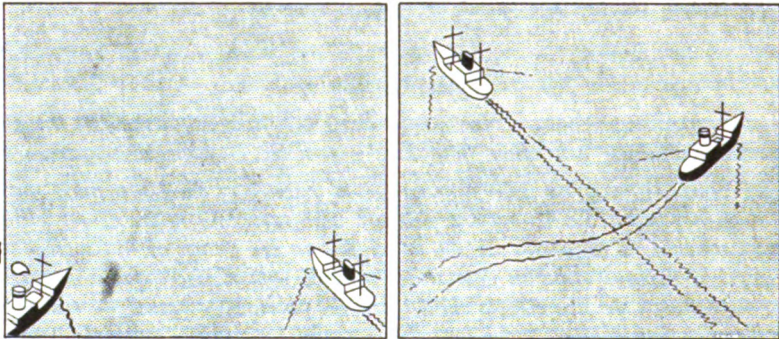
Proviso as to Dangers of Navigation, etc. In obeying and construing these rules due regard shall be had to all dangers of navigation and collision, and to any special circumstances which may render a departure from the above rules necessary in order to avoid immediate danger.



TWO STEAM VESSELS MEETING END-ON, OR NEARLY END-ON.

BOTH VESSELS ALTER COURSE TO STARBOARD.

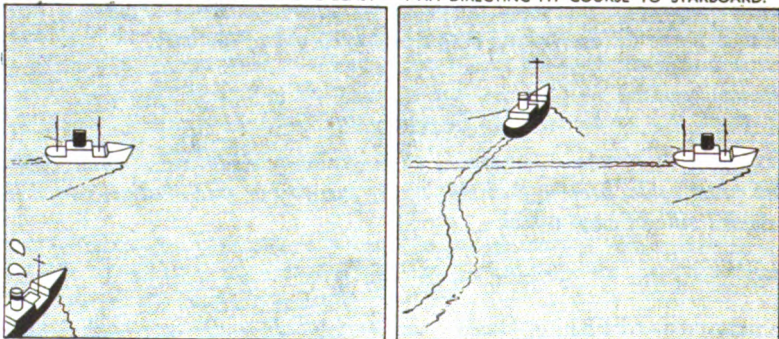
BOTH VESSELS SOUND ONE BLAST—"I AM DIRECTING MY COURSE TO STARBOARD."



TWO STEAM VESSELS CROSSING.

THE VESSEL WHICH HAS THE OTHER ON HER STARBOARD HAND GIVES WAY.

THE GIVING-WAY VESSEL SOUNDS ONE BLAST—"I AM DIRECTING MY COURSE TO STARBOARD."



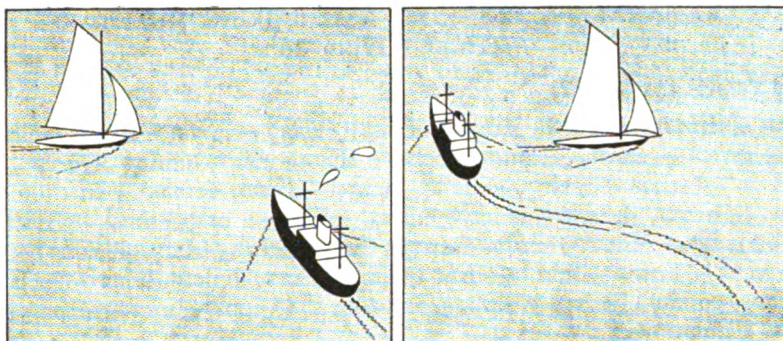
ONE STEAM VESSEL OVERTAKING ANOTHER.

OVERTAKING VESSEL KEEPS CLEAR OF THE OTHER.

OVERTAKING VESSEL SOUNDS TWO BLASTS—"I AM DIRECTING MY COURSE TO PORT."

Fig. 322. Examples of the Steering Rules**Miscellaneous Rules****ARTICLE 28**

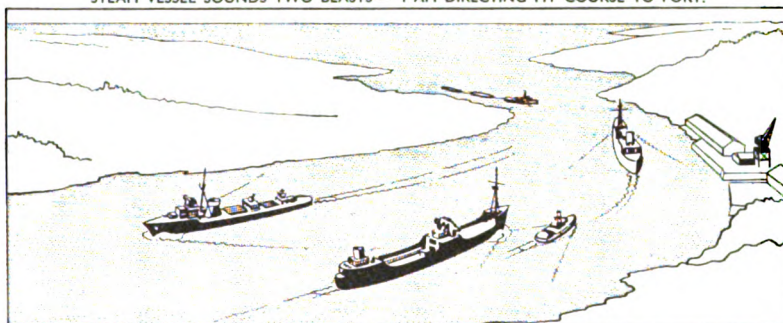
Sound Signals for Vessels in Sight of one another. *The words "short blast" used in this Article shall mean a blast of about one second's duration.*



STEAM VESSEL CROSSING SAILING VESSEL.

STEAM VESSEL GIVES WAY.

STEAM VESSEL SOUNDS TWO BLASTS—"I AM DIRECTING MY COURSE TO PORT."



STEAM VESSELS KEEP TO THE RIGHT-HAND SIDE OF A NARROW CHANNEL.

Fig. 322 (contd.) Examples of the Steering Rules

When vessels are in sight of one another, a steam vessel under way, in taking any course authorised or required by these rules, shall indicate that course by the following signals on her whistle or siren, viz :—

- one short blast to mean, " I am directing my course to starboard " ;*
- two short blasts to mean, " I am directing my course to port " ;*
- three short blasts to mean, " My engines are going full speed astern " .*

ARTICLE 29

No vessel Under Any Circumstances to Neglect Proper Precautions. Nothing in these rules shall exonerate any vessel, or the owner, or master, or crew thereof, from the consequences of any neglect to carry lights or signals, or of any neglect to keep a proper look-out, or of the neglect of any precaution which may be required by the ordinary practice of seamen, or by the special circumstances of the case.

ARTICLE 30

Reservation of Rules for Harbours and Inland Navigation. Nothing in these rules shall interfere with the operation of a special rule, duly made by local authority, relative to the navigation of any harbour, river or inland waters.

REMARKS ON STEERING AND SAILING RULES— ARTICLES 17 to 28*

Sailing Vessels (Article 17)

This article has been the subject of controversy ever since it was conceived because nowhere in the regulations have the terms “running free”, “close hauled”, “starboard tack”, and “port tack”, been defined. In the course of time, however, these terms have been defined in a broad sense by decisions given by judges of the Admiralty Court in cases resulting from collisions between sailing vessels, but it should be borne in mind that such definitions differ largely from those commonly used in sailing, and that they apply only to the provisions of these regulations.†

In so far as these regulations are concerned a sailing vessel is deemed to be :—

on the starboard tack when she is sailing with the wind on her starboard side, blowing from abeam or before her beam ;

on the port tack when she is sailing with the wind on her port side, blowing from abeam or before her beam ;

close-hauled when she is sailing with the wind on either side, blowing from abeam or before her beam ;

running free when she is sailing with the wind on either side, blowing from abaft her beam.

Steamships (Articles 18 to 27)

When obeying the Steering and Sailing Rules, the following points should be borne in mind :—

- (i) If yours is the giving-way vessel, always give the other vessel as wide a berth as circumstances allow. It is bad seamanship and bad manners to pass close aboard another vessel.
- (ii) If yours is the giving-way vessel your avoiding action should be made in such a manner as to leave no doubt of your intentions in the mind of the person in charge of the other vessel. You should therefore :—
 - (a) take avoiding action in plenty of time ;
 - (b) when altering course make a sufficiently large initial alteration to make your intentions clear ;
 - (c) steady on your new course without undue yawing ;
 - (d) make the appropriate sound signal.
- (iii) When another vessel is approaching, steer as steady a course as possible and make allowances for the other vessel yawing. A vessel approaching nearly end on, on an opposite course, may appear end on now and again because she is yawing. Under such circumstances she should be treated as approaching end on, and you should alter your course to starboard to give her as wide a berth as practicable.
- (iv) In a narrow channel keep to that side of the channel which is on your starboard hand.

* See also the chapter on “ Handling of Ships ” in Volume III of this Manual.

† For definitions of sailing terms as commonly applied see pages 281 to 283.

REMARKS ON SOUND SIGNALS FOR VESSELS IN SIGHT OF EACH OTHER—(ARTICLE 28)

- (i) Whenever a steam vessel takes avoiding action she must, by Article 28, indicate that action at the time it is taken by making the appropriate sound signal. The "short blast" may be made on a whistle, siren, klaxon horn, or other similar sound-producing instrument. Also, it is customary for all steam vessels within sight of other vessels to make these signals when altering course or going astern when manœuvring or in the process of normal navigation, and particularly when there is another vessel close astern.
- (ii) It is the custom to give an additional interpretation to the signal of three short blasts, *viz*: "My vessel is making way astern". Three short blasts may also be interpreted as meaning "My engines are going astern", and not necessarily "My engines are going full speed astern".
- (iii) The article requires these signals to be made by "a steam vessel underway in taking *any course authorised or required by these rules*"; it should be borne in mind, therefore, that the provisions of this article apply not only to the ship which has to give way, but also to the ship which, under Article 27, should hold her course, but has to alter course to avoid some navigational danger; and that it also applies to any ship which, under Articles 21 and 29, has to take avoiding action to avert an imminent collision.
- (iv) The article requires these signals to be made "when vessels are *in sight* of one another". The signals are not made in conditions of low visibility when ships, though close to each other, cannot see one another, because there is then a danger of such signals drowning, or being confused with, the fog signals of nearby shipping and of navigational marks. The signals are sometimes omitted when an alteration of course is made by ships which are within sight of each other, but are so far apart as to be outside the sound range of the siren, but it is prudent in these circumstances *always* to make the appropriate signal.
- (v) There is always a risk of a steam siren not working efficiently at first, owing to steam having condensed in the pipe. Great care must therefore be taken that another vessel does not interpret your signal incorrectly. For example, when wishing to sound two short blasts the first of these might be choked and the second quite correct, so that the other vessel might then interpret the signal as one short blast. If, therefore, choking does occur, repeat your signal a moment later; but, best of all, keep your siren clear.

NAVIGATION LIGHTS

Any vessel which is underway between the times of sunset and sunrise must exhibit the recognised "navigation lights", so that her classification, position, and course may be identified. The navigation lights which should be exhibited by a steam vessel 150 feet or more in length are illustrated in Plate 6 and described below. Navigation lights for smaller steam vessels, and those for sailing vessels, are described below and illustrated in the "Table of Lights and Daymarks" in Plate 7. It should be noted that the arcs over which the

navigation lights show correspond with the "right-of-way", "giving-way", and "overtaking" arcs illustrated in Fig. 320, and it is by this means that the course of a vessel may be estimated at night.

Navigation Lights of a Steam Vessel 150 feet or more in Length (Plate 6)

- (i) *Side-lights, sometimes called bow-lights; visible at least 2 miles on a clear night.* On the starboard side a green light, showing from right ahead to 2 points abaft the beam, *i.e.* from zero to green 112½. On the port side a red light, showing from right ahead to 2 points abaft the beam, *i.e.* from zero to red 112½. These lights are screened so that they cannot be seen from the opposite bow.
- (ii) *Overtaking light, sometimes called stern light; visible at least one mile* on a clear night.* At the stern, a white light at about the same height as the side-lights, showing from 2 points abaft the starboard beam, around the stern to two points abaft the port beam.
- (iii) *Steaming lights, sometimes called masthead lights† or range lights; visible at least 5 miles on a clear night.* On the foremast, higher than the side-lights and at least 20 feet above the gunwale, a white light called the "fore steaming light", showing from 2 points abaft the starboard beam, around the bows to 2 points abaft the port beam. On the mainmast, at least 15 feet higher than the fore steaming light, a white light called the "after, or main, steaming light", showing over the same arc as the fore steaming light. The after steaming light is optional for all vessels, but it is the usual practice for all vessels of over 150 feet in length (which are equipped with two masts) to carry both a fore and an after steaming light.

Navigation Lights of Small Steam Vessels

- (i) A steam vessel of under 40 tons gross tonnage may carry her steaming light (visible at least 2 miles on a clear night) in the fore part of the vessel, not less than 9 feet above her gunwale, and side-lights (visible at least one mile on a clear night) not less than 3 feet below the steaming light. Her side-lights may be of the type already described, or in the form of a "combined lantern" showing a green and a red light over their respective arcs. She should also carry, or show, an overtaking light.
- (ii) A small steamboat, such as a ship's boat or a harbour craft, may carry her steaming light less than 9 feet above her gunwale but it must be higher than her side-lights or combined lantern.

Navigation Lights of Sailing Vessels

- (i) All sailing vessels of over 20 tons gross tonnage carry only side-lights and an overtaking light, as prescribed for steam vessels of over 150 feet in length.

* By the 1910 Regulations the overtaking light need not be a fixed light, but should be shown to the overtaking vessel from the stern.

† This term is apt to be confused with the masthead signalling lights fitted in warships, and it is not therefore used in the Royal Navy.

- (ii) A sailing vessel of less than 20 tons gross tonnage may carry a combined lantern instead of the normal side-lights. If it is impracticable to fix the combined lantern it should be kept lighted and ready for use, and be exhibited over the correct arcs in sufficient time to prevent a collision.

Navigation Lights for Small Pulling Boats Under Oars or Sail

Such boats are required to carry only an all-round white light, which should be exhibited in time to prevent a collision. A warship's boat under oars carries this light on her foremost awning stanchion.

Remarks on Exhibition of Navigation Lights

Navigation lights are shown from sunset to sunrise by all vessels under way. A ship getting under way after sunset will switch off her anchor lights and switch on her navigation lights at the moment when the anchor is broken out of the bottom, or when the slip-rope clears the buoy, or when the last berthing hawser is cast off.

When coming to an anchor, or securing to a buoy or alongside, between sunset and sunrise, a vessel switches off her navigation lights and switches on her anchor lights as the anchor is let go, or as the picking-up rope is brought to the capstan, or when the first berthing hawser is made fast.

Navigation lights should be placed well clear of the vessel's normal lighting and so that their arcs of visibility are not obstructed by rigging or other fittings ; particular care should be taken when placing the side-lights to ensure that each is so screened that when viewed from ahead it cannot be seen from the opposite bow. Care must also be taken to ensure that no lights are visible from outboard which might be mistaken for the navigation lights ; any curtains provided for the side-scuttles should not be of red, green or blue materials because a light shining through them may be mistaken for one of the side-lights.

Navigation lights are usually electric, but oil-burning or battery-operated lights are provided for use in the event of an electricity failure. When at sea by night these secondary lights are kept lit, or ready for immediate use, and stowed in a handy place out of sight from outboard. If the normal navigation lights fail, the secondary lights are placed or hoisted into position. At sea, navigation lights and " not under command " lights should always be tested before sunset. At sunset, when navigation lights are switched on, they should be inspected to see that they are burning brightly, and at the same time the secondary navigation lights should be lit, or tested, and stowed ready for immediate use ; thereafter, during the night, the navigation lights should be inspected at least once every watch to ensure that they are burning with the required brilliance.

The electric circuits of the navigation lights of a warship are fitted with resistances to enable them to be dimmed to the required minimum brilliance in wartime.

A warship may be equipped with a powerful group-light, known as the " fog light ", which shows astern. This is switched on in fog to enable a ship astern to keep station.

A warship may also be equipped with a " shaded stern light ". This is a dim blue light, which shines over a restricted arc, by which a ship astern keeps station in wartime on dark nights when ships are darkened and not burning navigation lights.

Remarks on Sighting Navigation Lights

At night the direction in which a steam vessel is steering may be judged by the number of her navigation lights which are visible from any one direction, and by their positions relative to each other and to the vessel.

Because the steaming lights are the more brilliant they will usually be sighted on a clear night before the side-lights. If the steaming lights are in line the vessel will be end on ; if the higher light is to the right of the lower, she will be going from right to left ; and if the higher light is to the left of the lower, she will be going from left to right.

If a vessel's steaming lights and starboard side-lights only are sighted anywhere to starboard, she should pass clear to starboard or astern. Similarly, if her steaming lights and port side-light only are sighted anywhere to port, she should pass clear to port or astern. These remarks only apply to vessels which are not close aboard one another.

If a vessel's steaming lights and port side-light only are sighted to starboard and before 2 points before the beam, she will be on a converging course. Similarly, if her steaming lights and starboard side-light only are sighted to port and before 2 points before the beam, she will also be on a converging course. If these lights are sighted abaft 2 points before the beam, the vessel may be on a converging, a parallel, or a diverging course.

If one white light by itself is sighted it may be an overtaking light, and if so the sighting vessel will be in the overtaking sector of the other. If it is sighted before 2 points before the beam the other vessel may be on a converging, a parallel or a diverging course. If the light is sighted abaft 2 points before the beam the other vessel will be on a diverging course.

These remarks can be simply demonstrated by cutting out of paper the plan outline of a ship, marking thereon the visibility arcs of her navigation lights, and then placing this model on various courses and relative bearings.

Different Interpretations of a Single White Light Sighted at Sea

No lights met with at sea are capable of so many different interpretations as a single white light.

It may be :—

- (i) a vessel's anchor light ;
- (ii) the overtaking light of a vessel ;
- (iii) the single steaming light of a vessel with her side-lights not yet in sight ;
- (iv) the light of a small boat under oars or sail ;
- (v) the light of an open fishing boat with gear extending less than 150 feet ;
- (vi) the light of a sailing pilot vessel on her station, which has not yet shown her side-lights, and whose flare has not yet been seen ;
- (vii) the light of a sailing trawler which has not yet shown a flare ;
- (viii) the all-round white light of a steam trawler, seen from within her overtaking arc ;
- (ix) a light on shore ;
- (x) a bright star just above the horizon.

It is obvious that examples (ii) and (v) are very different, both as regards the action it will be necessary to take and the time when such action will be necessary. It is well always to be prepared for prompt and most pronounced avoiding action, bearing in mind the area the ship is in at the time and the

consequent likelihood of encountering such cases. It is not likely, for example, that a white light sighted in the middle of the Atlantic will be anything but (ii) or (iii) or (x), but if it were sighted in the Thames Estuary it might be any of the examples quoted above, except perhaps (vi).

RULES CONCERNING DAYMARKS AND LIGHTS

Any vessel not underway, or which if under way is unable to obey the Steering and Sailing Rules, either through force of circumstances or the nature of the duties on which she is engaged, is bound to exhibit by day certain shapes or flags called "daymarks", and by night certain lights, in order to distinguish her from vessels under way and under full powers of manœuvrability. Illustrations of these daymarks and lights are given in Plates 7 to 13 and the following information is given in amplification of them.

Warships at Anchor

By day a warship does not normally hoist a black ball* when at anchor, but the fact that she is at anchor, or made fast to the shore or to a buoy, may be indicated by her jack flying from her jackstaff. On occasions of celebration, warships in an anchorage may be ordered to dress ship; those at anchor dress overall with flags, and those under way fly a jack, masthead ensigns, and an ensign at the stern.

By night the anchor lights of a warship are usually displayed on her ensign and jack staffs. In accordance with naval custom a British flagship at anchor displays, in addition to her anchor lights, a white top-light on the after side of her mainmast, showing over an arc of 180° from beam to beam through right astern, and one, two, or three all-round white lights placed athwartships on her after superstructure. At sea a British flagship, or the ship of the senior officer of a squadron or flotilla, may display the top light in addition to her navigation lights.

Vessels Towing

The regulations do not give the right of way to a vessel which is towing, but it is the practice among seamen, and a sign of good sea manners, for other vessels to keep clear of her.

Vessels Not Under Command

A vessel is said to be "not under command" when she is not under full powers of manœuvrability, and other vessels should keep clear of her. A vessel may not be under command for many different reasons, and her daymarks and lights should not be interpreted as signals indicating distress.

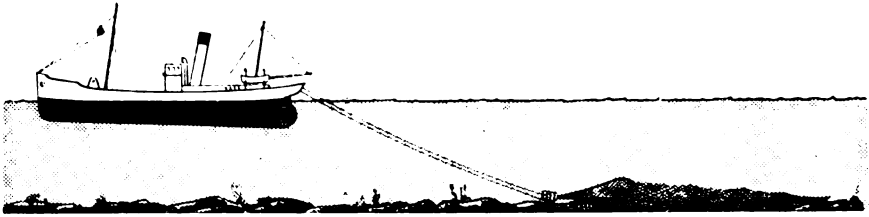
Fishing Vessels

The regulations lay down that sailing vessels shall keep clear of sailing vessels or boats which are fishing with nets, lines or trawls. Though not laid down in the regulations it is good manners and good seamanship, and therefore customary, for steam vessels to keep clear of steam fishing vessels which are fishing with nets, lines or trawls.

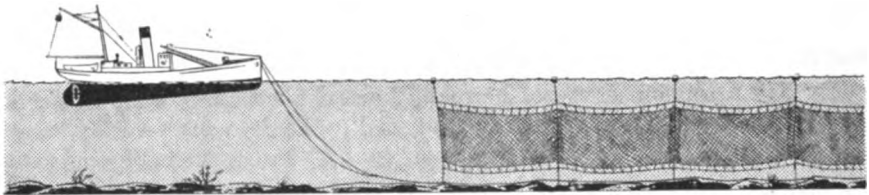
Fig. 323 shows the difference between fishing by trawl and by drift-net; a drifter is virtually moored by her bows to her nets, which may extend as much

* By the 1910 regulations ships at anchor are not required to display a black ball.

as 4 miles ahead of her, but a trawler tows her trawl astern along the bottom. A seine-net vessel shoots her nets in a circle and then lies to leeward of them as she hands them, and her nets may encircle an area of as much as a square mile.



(i) A TRAWLER TRAWLING



(ii) A DRIFTER LYING TO HER NETS

Fig. 323

Seaplanes*

A seaplane under way on the water is deemed to be a steam vessel in so far as the steering and sailing rules are concerned, and she must take the appropriate avoiding action. It should be borne in mind, however, that an aircraft cannot go astern, and may be unmanœuvrable when about to take-off, or just after alighting, or in a high wind. It is therefore prudent as well as good manners to keep clear of the path of an aircraft which is about to alight or take-off, and to navigate in her vicinity with due regard for her limited powers of manœuvrability.

Miscellaneous Harbour Regulations

The *Regulations for Preventing Collisions at Sea* are observed generally by all vessels when navigating or manœuvring in harbours, rivers, lakes or inland waters, but in these waters they may be modified to suit local conditions, as provided for by Article 30 of the Regulations. The local regulations of one port may differ considerably from those of another, even when they apply to vessels of similar type in similar circumstances and even when the ports are situated close to one another; a dredger moored in Portsmouth Harbour, for example, displays very different lights and daymarks to those displayed by a dredger moored only eight miles away in Southampton Water. Before entering a harbour the seaman should therefore consult the relevant *Sailing Directions* and the current *Notices to Mariners* (particularly No. 1 of each year) in which the more important local traffic rules of a port are usually given, and he should also ascertain the seaward limits within which such rules are applicable. As soon as possible after entering the harbour he should obtain a copy of the local port regulations. Some fairly common rules observed by vessels in harbours, and some examples of lights and daymarks displayed by vessels and craft in

* No provision for seaplanes was made in the 1910 Regulations, but the regulations concerning them were agreed to internationally in 1929.

harbours, are given below. Some are authorised by local regulations, and some by the *International Code of Flag Signals*.

VESSELS HAVING RIGHT OF WAY

An important rule in force in nearly all harbours is that ships or craft crossing the harbour must keep out of the way of ships entering or leaving it, that outgoing ships have right of way over incoming ships, and that ships going down-stream have right of way over ships going up-stream.

VESSELS TO BE PASSED AT SLOW SPEED

Vessels such as dredgers, salvage vessels and mooring vessels, may require other vessels passing them to do so at slow speed ; if so they fly the International Code Signal *T.E.* This signal may also be flown by a ship berthed alongside or it may be flown on the banks of a river or a channel.

Boats and vessels must pass at slow speed any place where divers are at work. The presence of divers is commonly indicated by a red flag flown in a ship or on shore and also in the diving boat. In H.M. ships it is a triangular flag and is flown at the yardarm on the side on which the divers are at work.

SHIPS EMBARKING OR DISEMBARKING EXPLOSIVES, OIL FUEL OR PETROL

Ships embarking or disembarking explosives should fly at the yardarm Flag B (red burgee) of the *International Code of Signals*. This flag is also flown by H.M. ships when embarking or disembarking oil fuel or petrol.

SHIPS CARRYING DANGEROUS CARGOES

Daymarks and lights which may be displayed by ships in harbour which are carrying dangerous cargoes, such as explosives and petrol, are prescribed by local port regulations and may therefore vary from port to port. A common daymark for ships carrying explosives, whether at anchor or underway, is a rectangular red flag usually flown at the fore masthead, and a common daymark for ships carrying petrol is a rectangular red flag with a circular white centre also usually flown at the fore masthead. It is common for both types of ships to display at night an all-round red light, above the riding light when at anchor, and an all-round red light at the fore masthead in addition to the navigation lights when under way.

DREDGERS

Lights and daymarks displayed by dredgers are prescribed by local port regulations, and they may therefore differ from port to port.

A dredger moored in the fairway of one of H.M. dockyard ports displays by night, amidships, three all-round white lights in the form of a triangle, apex up, in addition to her anchor lights ; in such case a vessel may assume it is safe to pass the dredger on either side. If the fairway on one side or other of the dredger is obstructed, the white light of the triangle on the dredger's obstructed side is replaced by a red light. By day the three white lights are replaced by three black balls, and a red flag replaces the red light on an obstructed side. In low visibility the dredger sounds, at intervals of not more than one minute, a gong rung rapidly for about 5 seconds.

FERRIES

Lights and daymarks displayed by ferries plying across a harbour are prescribed by local port regulations, and they may therefore differ from port to

port. It is usual for ferries to give way to vessels entering or leaving harbour.

Ferries in H.M. dockyard ports which are drawn by chains from one landing to the other carry by night four lights, one at each corner, showing white ahead and astern, and red on the beam, visible 2 miles.

H.M. SHIPS ENTERING OR LEAVING ONE OF H.M. DOCKYARD PORTS

When ships over a certain tonnage are entering or leaving, or are under way in, the ports of Chatham, Sheerness, Portsmouth, Portland, Devonport, Plymouth, Rosyth and Pembroke, the following signals are to be displayed :—

By Ships Entering, Leaving, or Underway :—

By day—Flags ZV.

By night—a red light at the masthead.

By Other H.M. Ships Present :—

Ships in certain berths, as detailed in local orders, fly Flags ZU as a warning to other vessels under way. It is the custom in H.M. ships to hoist the ensign at the peak when another ship is under way in harbour before Colours or after Sunset, if it is light enough for it to be seen.

MODERN BRITISH AIRCRAFT CARRIERS

Some modern British aircraft carriers when at anchor may exhibit the following anchor lights instead of the normal anchor lights :—

four white lights, one at each bow and one at each quarter, each visible over an arc of at least 180°; the two forward lights on a level not more than 5 feet below the flight deck, and the two after lights on a level not less than 15 feet below the forward lights.

SOUND SIGNALS FOR USE IN LOW VISIBILITY

In low visibility such as occurs in fog, mist, snow, or heavy rain, a vessel under way must, both by day and at night, moderate her speed and sound the prescribed signals for warning other vessels of her presence or her approach, and for informing them of her category. *If a vessel hears the sound signal of another vessel before her beam she should stop engines and proceed with caution until danger of collision is over.*

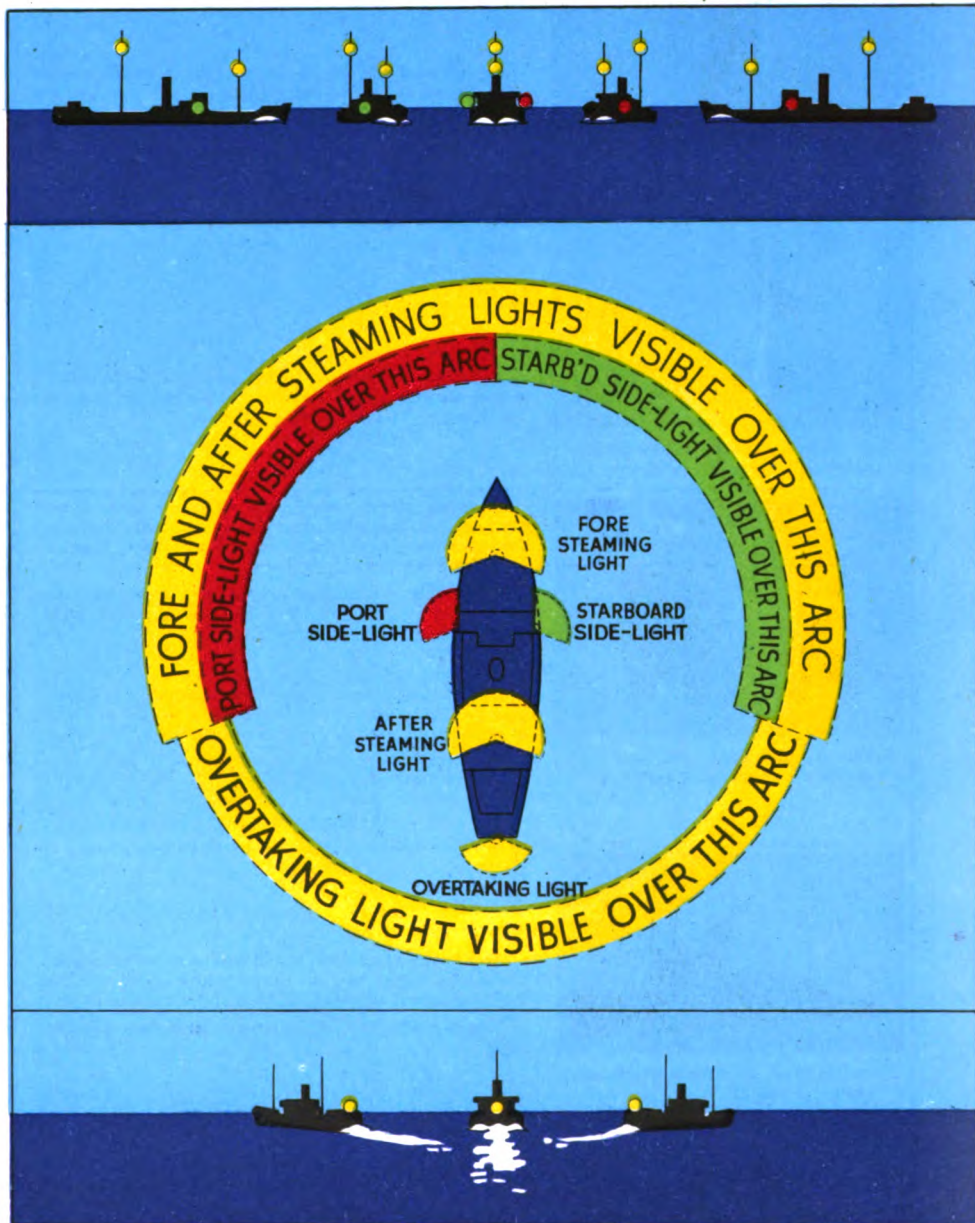
The sound signals for low visibility are shown in the plates of "Lights and Daymarks" opposite, and are also given below. The words "prolonged blast" mean a sound of about 5 seconds duration on the siren or foghorn. It should be noted that a foghorn is worked by hand or blown by a man, and its sound differs from, and is not so loud as, that of a siren worked by electricity, steam or compressed air. The sound of a foghorn usually indicates the presence of a sailing vessel.

Signals on a steam whistle or siren, at intervals of not more than TWO minutes:

Signal	Meaning
One prolonged blast :	steam vessel under way and having way upon her.
Two prolonged blasts :	steam vessel under way, but stopped and having no way on.
One prolonged blast, followed by two short blasts (letter D in Morse Code) :	a vessel towing or being towed,* or a cable ship at work, or a vessel under way but not under command, or a vessel engaged in sweeping.

(Continued on page 579.)

* The towed vessel should make this signal on the foghorn.



NAVIGATION LIGHTS OF A STEAM VESSEL,
150 FEET OR MORE IN LENGTH

LIGHTS, DAYMARKS AND FOG SIGNALS OF VESSELS



Sailing vessel under way at night ; bows on.

A sailing vessel under way at night carries side-lights or a combined lantern, and an overtaking light.

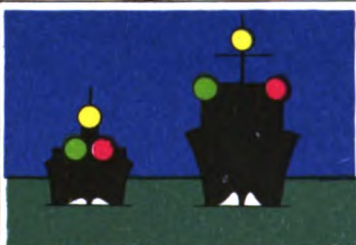
In low visibility, day or night, sailing vessels under way sound the following signals on the foghorn at intervals of not more than one minute :—

*one blast —vessel on the starboard tack ;
two blasts —vessel on the port tack ;
three blasts—vessel running with the wind abaft the beam.*



Side view of vessel under sail and mechanical power, by day.*

A vessel proceeding under sail and mechanical power by day carries where it can best be seen a black cone, hoisted point uppermost.*



Small steam vessel, and warship, under way, at night ; bows on.

A small steam vessel less than 40 tons gross tonnage, under way at night, may carry only a fore steaming light, an overtaking light, and a combined lantern.

A warship without a mainmast, under way at night, may carry only a fore steaming light, an overtaking light, and side-lights.

In low visibility, day or night, steam vessels under way sound the following signals on the whistle or siren at intervals of not more than 2 minutes :—

*if making way—one long blast.
if stopped —two long blasts.*



Vessel 150 feet or more in length, at anchor, at night.

Any vessel at anchor, if 150 feet or more in length, carries by night two all-round white lights, viz., a "riding light" on her fore stay, and a stern light aft.

Vessels under 150 feet in length carry only a riding light.



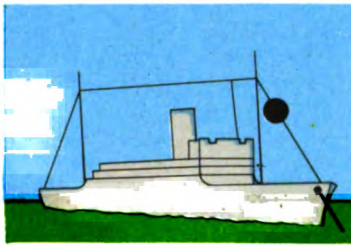
Flagship of an Admiral, at anchor, at night.†

A warship at anchor by night carries her riding light and stern light at the trucks of her jack staff and ensign staff respectively. A flagship may carry, in addition to her riding light and stern light, a top-light and poop lanterns.† The number of poop lanterns indicates the rank of the admiral, viz., one for a Rear-Admiral, 2 for a Vice-Admiral, and 3 for an Admiral.

*Not included in the 1910 Regulations.

†This is a custom for H.M. ships only.

LIGHTS, DAYMARKS AND FOG SIGNALS OF VESSELS



Vessel at anchor, by day.*

A vessel at anchor may display by day a black ball in place of her riding light.*



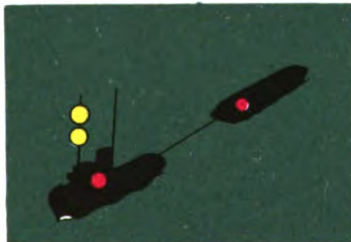
Warship at anchor, by day.†

A warship at anchor by day does not display a black ball but usually flies a jack at her jack staff in addition to the ensign at her ensign staff from 0800 or 0900 to sunset.

In low visibility, day or night, a steam or sailing vessel at anchor sounds, at intervals of not more than one minute :—

a bell rung rapidly for about 5 seconds.

*A vessel over 350 feet in length may ring a bell forward and a gong (or other such instrument) aft. The tone of the gong (or instrument) must be distinct from that of the bell.**



Vessel towing another at night ; length of tow less than 600 feet.

A steam vessel towing a vessel at night carries side-lights and an additional steaming light below her fore steaming light. She does not carry an after steaming light, but she may carry a small white light, not visible before the beam, for the vessel towed to steer by.

The vessel towed carries side-lights only.



Vessel towing more than one vessel at night ; length of tow over 600 feet.

If more than one vessel is towed, and the length of the tow exceeds 600 feet, she carries another steaming light above her original fore steaming light (making 3 in all).

In low visibility, day or night, a steam vessel towing sounds the following signal on her siren, or whistle, at intervals of not more than 2 minutes :—

one long blast followed by 2 short blasts.

The vessel towed, or the last vessel in the tow, may sound a long blast followed by 2 short blasts, usually made immediately after the signal sounded by the towing vessel.

*Not included in the 1910 Regulations.

†This is a custom for H.M. Ships only.

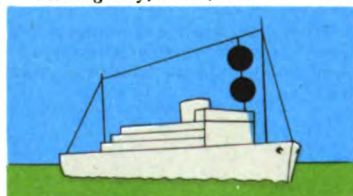
LIGHTS, DAYMARKS AND FOG SIGNALS OF VESSELS



Vessel not under command and stopped, at night.



Vessel not under command but making way, at night.



Vessel not under command, by day.

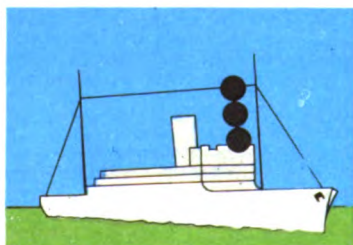
A vessel under way at night but not under command hoists two all-round red lights, one above the other, visible 2 miles, and dowses her steaming lights; if she is making way through the water she burns her side-lights as well. By day, a vessel not under command hoists two black balls.

In low visibility, day or night, a vessel not under command sounds, at intervals of not more than 2 minutes :—

one long blast followed by two short blasts.



Vessel aground, by night.



Vessel aground, by day.*

A vessel aground displays the following lights or daymarks :—

by night, two all-round red lights one above the other and her anchor lights;

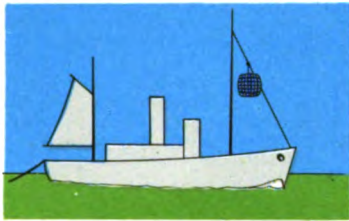
by day, three black balls, one above the other.*

*In low visibility, day or night, a vessel aground may make the following sound signal at intervals of not more than one minute :—**

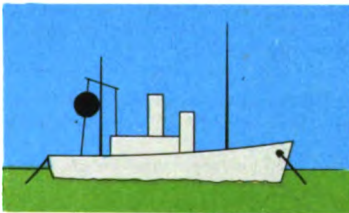
the fog signal for a vessel at anchor, preceded and followed by 3 separate and distinct strokes on the bell.

*No daymark or fog signal for a vessel aground in or near a fairway is included in the 1910 Regulations.

LIGHTS, DAYMARKS AND FOG SIGNALS OF VESSELS



A fishing vessel under way, by day, with her gear out.



A fishing vessel at anchor, by day, with her gear out. Vessels may pass her on the side on which the basket or shape is hoisted.

All vessels or boats fishing with nets, lines, or trawls, when under way in daytime, display a basket, or black ball, or shape, where it can best be seen. If at anchor with their gear out they display the signal on the side or at the end which a vessel may pass.

All fishing vessels when fishing at night may burn a white flare to attract attention to their position. This flare is in addition to their special fishing lights, which are described hereafter.

Fishing vessels and boats when not fishing do not display daymarks, and at night they carry the normal lights for their type of vessel.

In low visibility, by day or night, a fishing vessel of 20 tons gross tonnage and upwards, when engaged in trawling, line or net fishing, makes the following sound signal at intervals of not more than one minute :—

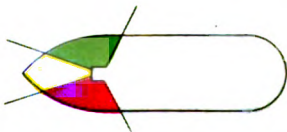
one blast on the siren or foghorn, followed by the rapid ringing of a bell for about 5 seconds.

Fishing vessels of under 40 tons gross tonnage need not make this signal but they must make some efficient sound signal at similar intervals.

In low visibility and when not fishing they sound the normal signal for their type of vessel.



A steam trawler trawling at night.



Arcs of visibility of a steam trawler's tricolour lantern.

A steam trawler engaged in trawling at night carries the following lights instead of the normal navigation lights :—

in place of her fore steaming light, a tricolour lantern, showing a white light from right ahead to two points on each bow, and a red light and a green light showing from two points on the bow to two points abaft the beam, on the port and starboard sides respectively; below this combined lantern she carries an all-round white light.

A sailing trawler engaged in trawling at night carries an all-round white light at her masthead, and should show a white flare on the approach of another vessel.

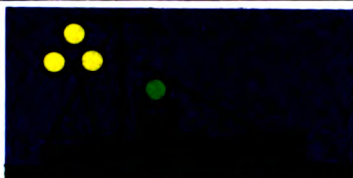
Vessels should not pass close astern of a trawler when she is trawling.



A steam drifter lying to her nets, at night.

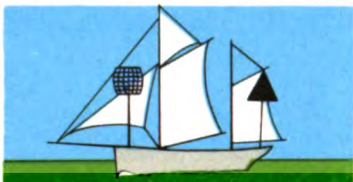
A drift-net fishing vessel with nets in the water, or an open boat with fishing gear extending for more than 150 feet, or a fishing vessel under 150 feet long at anchor with fishing gear down, carries at night two all-round white lights, the lower of which indicates the direction of the fishing gear.

LIGHTS, DAYMARKS AND FOG SIGNALS OF VESSELS



A steam seine-net fishing vessel shooting her nets, at night.*

A seine-net fishing vessel* carries at night three all-round white lights, in the form of a triangle, at her yard-arm. When making way while shooting her nets she shows side-lights as well, but not steaming lights.

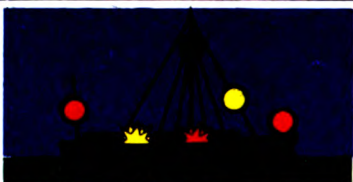


A sailing seine-net fishing vessel shooting her nets, by day.*

By day a seine-net fishing vessel displays a basket, black ball, or shape, in her fore-rigging, and a black cone at her mizzen yard-arm on the side on which she is working the net.

When approached by another vessel, *whether in clear or low visibility*, a seine-net fishing vessel may sound :—*

three long blasts and one short blast on the siren or whistle.



A light vessel out of position, at anchor, at night.*

A light vessel not in her proper position at night* dowses her main light and carries an all-round red light at each end. In addition she burns a red and a white flare, simultaneously, every fifteen minutes ; if she cannot burn flares she shows a red and a white light instead. If anchored she carries her riding light, and if under way she shows her side-lights.



A light vessel out of position, by day.*

By day, a light vessel not in her proper position* hoists a black ball at each end and flies the International Code Signal PC. In addition, her day-mark is lowered if practicable.

In low visibility, a light vessel not in her proper position sounds the normal signals for a vessel under way or at anchor.



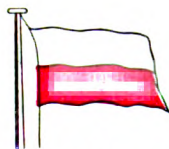
A steam pilot vessel under way, at night.*

Any pilot vessel when engaged on her station on pilotage duty by night, whether at anchor or under way, does not display the normal navigation lights or anchor lights for a vessel of her type, but instead displays at her masthead an all-round white light, visible 2 miles, and burns a white flare at intervals not exceeding 15 minutes. If making way she also displays her side-lights, but dowses them when she stops or anchors.

A steam pilot vessel, in addition to these lights displays below her white masthead light an all-round red light visible 2 miles.

By day a pilot vessel may fly the pilot vessel flag—a white and red horizontal flag.*

Pilot vessels not engaged on pilotage duty display the normal lights and shapes prescribed for vessels of their type.



Pilot vessel flag.*

In low visibility pilot vessels sound the normal signals for vessels of their type.

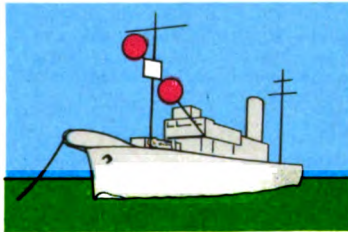
*This is not a provision of the *Regulations for Preventing Collisions at Sea*.

LIGHTS, DAYMARKS AND FOG SIGNALS OF VESSELS



A cable-laying vessel making way, at night.

A vessel under way employed by night in laying or picking up a submarine cable does not display steaming lights, but in place of her fore steaming light she displays two all-round red lights with an all-round white light between them, each visible for a distance of at least 2 miles. If she is making way she burns her side-lights as well.



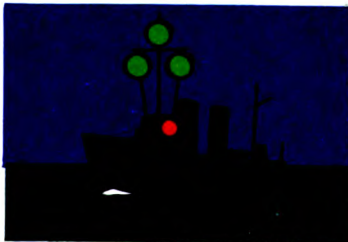
A cable-laying vessel, by day.

By day she hoists two round red shapes with a white diamond shape between them.

These lights and shapes when displayed by a vessel signify that she is not under command.

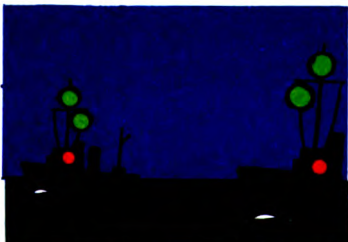
In low visibility she sounds, at intervals of not more than 2 minutes :—

one long blast followed by two short blasts.



Sweeping vessels operating singly, at night.*

H.M. ships, operating singly or in formation, and engaged in minesweeping operations or exercises,* carry at night three all-round green lights in the form of a triangle on their foremasts, and carry their side-lights. Such vessels should not be approached within 900 yards.



Sweeping vessels towing a sweep between them, at night.*

When two vessels are towing a sweep between them at night,* each shows two all-round green lights on her foremast, in addition to her side-lights; the lower of the green lights indicates the direction of the sweep. Ships should not pass between, or cross astern within 400 yards of, two or more sweeping vessels working a sweep or sweeps.

By day sweeping vessels* carry black balls instead of the green lights.

In low visibility vessels under way with sweeps out may sound at intervals of not more than 2 minutes :—

*one long blast followed by two short blasts.**

*Not included in the *Regulations for Preventing Collisions at Sea*, but laid down in *Admiralty Notices to Mariners*.

LIGHTS, DAYMARKS AND FOG SIGNALS OF VESSELS



Examination vessel's flag.*



Examination vessel at night, port open.*



Examination vessel by day, port closed.*

At British ports an Examination Service may be instituted in times of emergency. Ships arriving at the port may be met by an Examination Service vessel which flies the flag illustrated.*

If the port is open to shipping the vessel will carry no other signal by day; by night she will carry three all-round white lights vertically from her fore yard-arm in addition to her navigation lights.*

If the port is closed to shipping the vessel will carry by day three red balls vertically from her fore yard-arm, and by night three all-round red lights in place of the balls in addition to her navigation lights.*



Seaplane, taxiing, at night.†



Seaplane, more than 150 feet in length, but less than 150 feet in span, at anchor, at night.†

A seaplane under way on the water by night† carries :—

- (i) in the fore part amidships a white "steaming" light, visible at a distance of at least 3 miles, and showing from right ahead to 20 degrees abaft the beam on each side;
- (ii) on the starboard and port wing tips, a green and a red "side-light" respectively, visible at a distance of at least 2 miles and showing from right ahead to 20 degrees abaft the beam on their respective sides;
- (iii) on the tail a white "stern" light, visible at a distance of at least 2 miles and showing from right astern to 20 degrees abaft the beam on each side.

A seaplane at anchor by night carries :—

- (i) if less than 150 feet in length, an all-round white "riding" light, visible at a distance of at least 2 miles;
- (ii) if 150 feet or more in length, an all-round white "riding" light and an all-round white "stern" light, each visible at a distance of 3 miles; and, if 150 feet or more in span, on each wing tip an all-round white light visible at a distance of at least one mile.

In low visibility a seaplane on the water is *not* obliged to make the sound signals of other vessels or craft, but if she does not make these signals she must make some other efficient sound signal at intervals of not more than one minute.

*Not included in the *Regulations for Preventing Collisions at Sea*, but laid down in *Admiralty Notices to Mariners*.

†Not included in the 1910 Regulations, but agreed to internationally in 1929.

Signals on the foghorn, at intervals of not more than ONE minute

<i>Signal</i>	<i>Meaning</i>
One blast :	sailing vessel under way on starboard tack.
Two blasts :	sailing vessel under way on port tack.
Three blasts :	sailing vessel under way with the wind abaft the beam.

Signals on a bell and/or a gong, at intervals of not more than ONE minute

<i>Signal</i>	<i>Meaning</i>
A bell rung rapidly for about 5 seconds :	a vessel at anchor.
A bell <i>and</i> a gong (or other instrument) rung rapidly for about 5 seconds : *	a vessel over 350 ft. in length at anchor ;* the bell is rung forward ; the gong (or other instrument), the sound of which must be distinct from that of the bell, is sounded aft.
A bell rung rapidly for about 5 seconds, preceded and followed by three separate and distinct strokes on the bell : *	a vessel aground, in or near a fairway.*
A gong rung rapidly for about 5 seconds : †	a dredger moored in or near a fairway, in one of H.M. dockyards ports.†

Signals on a siren or a foghorn and on a bell, at intervals of not more than ONE minute

One blast followed by a bell rung rapidly for about 5 seconds :	a fishing vessel of 20 tons gross tonnage and upwards which is engaged in fishing. Smaller fishing vessels need not make this signal, but they must make some efficient sound signal at similar intervals when engaged in fishing.
---	--

OTHER SOUND SIGNALS‡**Signals Authorised by the "International Code of Signals"**

The sound signals in the following table may be sounded by a vessel in clear weather to attract attention, to warn other vessels, or to indicate her course of action. They should be used with discretion to avoid confusion with the more important sound signals prescribed in the *Regulations for Preventing Collisions at Sea*, and, with the exception of the first signal, their use in fog should be reduced to a minimum. The signals are those of the Morse Code, sounded on the siren or foghorn, the duration of the short and long blasts being the same as those for the sound signals described above.

* Not included in the 1910 Regulations.

† This is a local harbour regulation.

‡ Not included in the *Regulations for Preventing Collisions at Sea*.

<i>Signal</i>	<i>Signification</i>
R (. - .) ...	" The way is off my ship ; you may feel your way past me ". (<i>This is a useful signal in low visibility.</i>)
U (.. -) ...	" You are standing into danger ".
V (... -) ...	" I require assistance ".
K (- . -) ...	" You should stop your ship instantly ".
O (- - -) ...	" Man overboard ".
F (... - .) ...	" I am disabled ; communicate with me ".
L (. - . .) ...	" You should stop ; I have something important to communicate ".
P (. - - .) ...	" Your lights are out, or burning badly ".

Signals Used in H.M. Dockyard Ports, and in Some Other Ports

H (....) ...	" Keep out of my way because I cannot keep out of yours ". (<i>This is used by ships when entering or leaving harbour to warn harbour craft to keep clear.</i>)
H.E. (.... .)	" My ship is practically stopped but turning to star-board ".
H.I. (.... .)	" My ship is practically stopped but turning to port ".

A Signal Used in Some Ports and Inland Waterways

One long blast of about 10 seconds duration.	This signal is used in many ports and rivers by a vessel approaching a bend or corner to give warning of her approach.
--	--

Signal by a Seine-net Fishing Vessel on the Siren, Foghorn or Whistle

Three long blasts followed by one short blast (- - - .)	Sounded on the approach of another vessel to indicate that she is shooting or handing her nets.
---	---

DISTRESS SIGNALS

(*Authorised by Article 31 of the International Regulations for Preventing Collisions at Sea, 1910*)

A vessel requiring assistance from shore or from another vessel may make any of the following signals, either together or separately :—

- By Day and by Night* ... International Code signal SOS (Morse code), or MAYDAY (radio telephony).*
- A gun or other explosive signal fired at intervals of about one minute.
- Continuous sounding of any fog signalling apparatus.

* Not included in the 1910 Regulations, but agreed to internationally in 1929.

- By Day only* ... A square flag, having above or below it a ball, or anything resembling a ball.
The flag signal *N.C.* of the International Code.
- By Night only* ... Flames on the vessel (as from a burning tar barrel, oil barrel, etc.).
Rockets or shells throwing stars of any colour or description, fired one at a time at short intervals.

SPECIAL SIGNALS*

Fishing Vessels.—A fishing vessel wishing to communicate urgent information to H.M. ships at sea hoists a fishing basket or shape over her fishing burgee or pendant.

Vessels Running Taut Wire Gear fly Flag *D*. They should not be approached within 1,000 yards.

Vessels Running Speed Trials fly Flag *A*.

British Pilot Signals.—The following signals indicate that a ship requires a pilot :—

By Day—

- (i) International Code Flag *G*, or
- (ii) International Code Flags *P.T.*

By Night—

- (i) a pyrotechnic light called a " blue light ", shown every 15 minutes ;
- (ii) a bright white light, flashed or shown just above the bulwarks for about one minute, at short or frequent intervals ; or
- (iii) International Code signal *P.T.* by the Morse code on a flashing lamp.

When Searchlights Interfere with Navigation.—Any vessel approaching or under way in a British port (and also some foreign ports), where searchlights are being worked, and finding that they interfere with her safe navigation, may make use of the following signals :—

- (i) *by flashing*—two long flashes, two short flashes, followed by three long flashes ;
- (ii) *by whistle, siren or foghorn*—two long blasts, two short blasts, followed by three long blasts.

Whenever possible, both the flashing and sound signals should be used, but either may be used alone.

* Not included in the *Regulations for Preventing Collisions at Sea*.

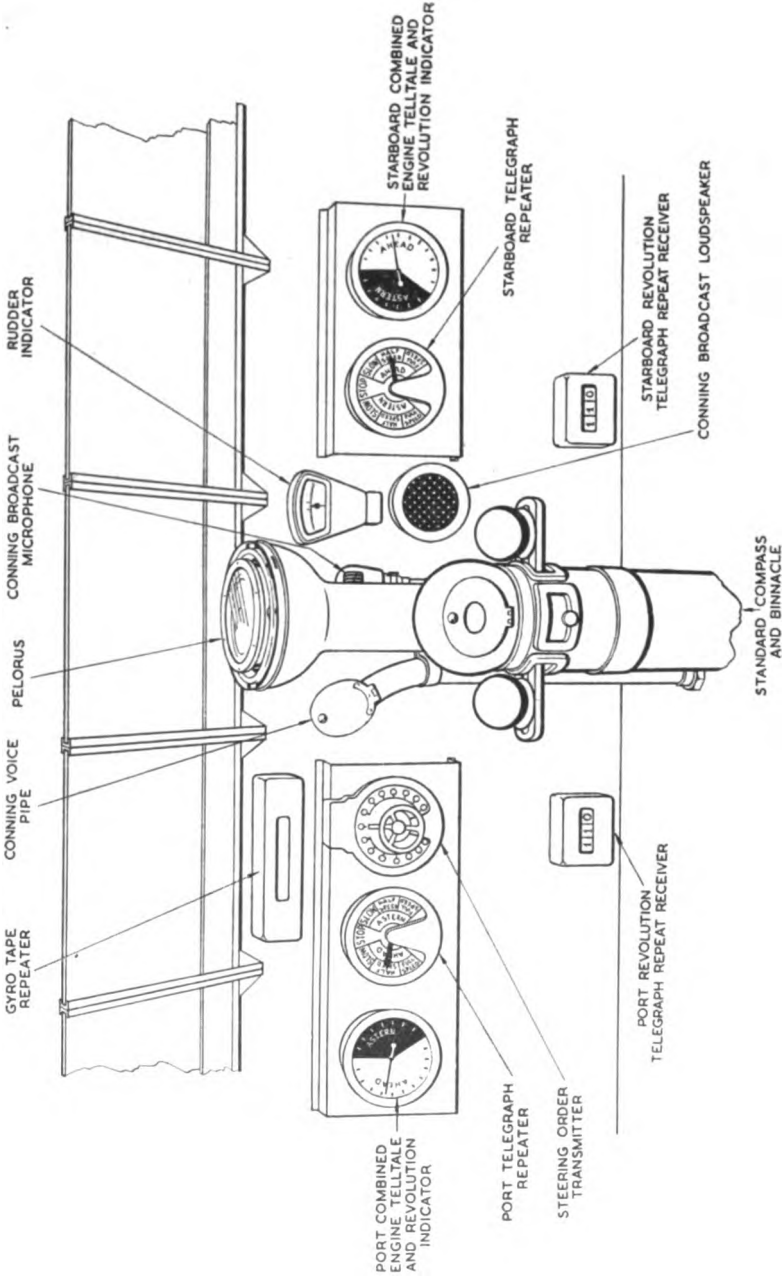


Fig. 324. Conning instruments on the bridge

CHAPTER XIX

Conning and Steering

Compasses

THE latest large warships are equipped with three gyro-compasses, situated behind armour and below the waterline, which operate repeaters in the conning and steering positions. The repeater on the compass platform is called the "Pelorus", and that in the steering position, the "steering repeater". At sea all three gyro-compasses are kept running, and their accuracy is frequently checked by comparison with one another. A change over switch is fitted on each repeater to enable it to be run off any one of the gyro-compasses, and, as a precaution against failure of a compass, it is standard practice to run the Pelorus and the steering repeater off different compasses.

Older or smaller warships may be equipped with magnetic compasses in addition to one or two gyro-compasses. The magnetic compass on the compass platform is called the "standard compass", and that at the steering position is called the "steering compass". The primary means of conning and steering is by gyro-compass repeater, and the secondary means is by magnetic compass. In such ships the accuracy of the Pelorus is checked frequently by comparison with the standard compass, and whenever the quartermaster steadies on a new course he must be ready at a moment's notice to steer by the steering compass, and should therefore immediately compare the gyro and magnetic courses.

The oldest warships, most small craft, and all boats, are equipped with magnetic compasses only.

A Gyro Alarm System, consisting of bells and red lamps connected electrically with each gyro-compass, is installed for indicating faulty functioning. A bell or a lamp, or both, are fitted at the main switchboard, on the compass platform, and at the forward steering position. If a fault occurs in any gyro-compass while running, the bells ring and the lamps burn, and the Officer of the Watch should at once be informed.

Conning Communications and Instruments (Figs. 324 and 325)

The compass platform and primary steering positions are equipped with certain instruments and fittings, the purpose and functions of which every seaman should know.

CONNING VOICE-PIPE

This leads from the compass platform to the forward steering position, and is the normal means by which conning orders are passed by word of mouth from the Officer of the Watch to the quartermaster. Orders from other conning positions are passed by telephone and "steering order transmitters" and "receivers".

CONNING BROADCAST SYSTEM

This system of microphones and loud-speakers is (1950) replacing the conning voice-pipe in large modern ships as the primary means of passing orders from the compass platform to the forward steering position.

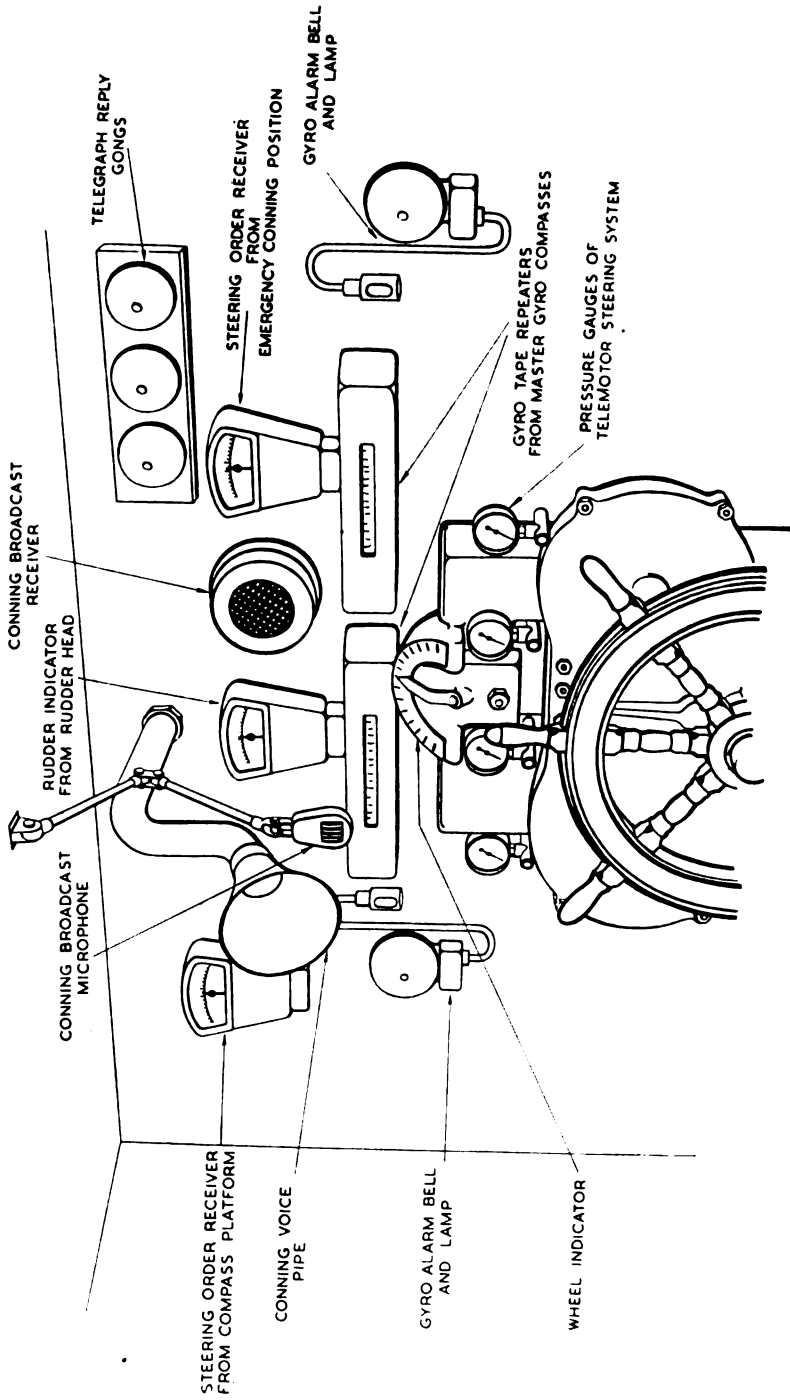


Fig. 325. Conning and steering instruments in the steering position

STEERING ORDER TRANSMITTER AND RECEIVER

These are electrically controlled instruments having a pointer which moves over a dial, marked in 5 degree steps up to 35 degrees, port and starboard, and with positions for the orders "Midships" and "Steady". Transmitters are provided at the primary and emergency conning positions, and receivers are provided at all steering positions. Before steering orders are passed by these instruments the order "Obey steering order receiver" is given by word of mouth, and when it is no longer required to pass the orders by this means the order "Disregard steering order receiver" is given by word of mouth. In the event of a complete breakdown in other means of communication between conning and steering positions, the movement of the receiver pointer several times over its range is the order to obey the steering order receiver.

WHEEL INDICATOR

This is provided in all steering positions to show the helmsman the amount the wheel has been turned. It consists of a pointer geared to the wheel mechanism, and moves round a scale marked in degrees from 0 to 35, both to port and to starboard.

RUDDER INDICATOR

One of these indicators is provided on the compass platform, and another at the steering position, to indicate the movements of the rudder to the Officer of the Watch and the quartermaster, respectively. They are driven electrically off the rudder head.

The rudder indicator should follow the wheel indicator; if they fail to register the same movement it means that the rudder is not lined up with the wheel, or that there is something wrong with the steering mechanism, and such failure must immediately be reported to the Officer of the Watch.

TELEGRAPH REPEATERS

These are situated on the compass platform, one for each set of main engines. They are electrically connected with the telegraphs and are operated as the telegraph orders are transmitted from the steering position.

COMBINED ENGINE TELL-TALES AND REVOLUTION INDICATORS

These are situated on the compass platform, one for each set of main engines. They are electrically connected with the propeller shafts and indicate the direction in which, and speed at which, each shaft is turning.

REVOLUTION TELEGRAPH REPEAT RECEIVERS

These are situated on the compass platform, one for each revolution telegraph, to which they are electrically connected. They indicate the number of revolutions per minute to which the revolution telegraphs have been set.

Precautions Before Proceeding to Sea

Before a ship gets under way the following precautions are always carried out in order to ensure that the steering and main machinery systems are in order :—

By the Engine-room Staff.—Each main engine is moved ahead and astern (after permission has been obtained from the Officer of the Watch).

All telegraphs are moved through their complete range, and their respective repeaters are checked.

The steering system is connected up and the wheel turned from hard-a-starboard to hard-a-port twice and then returned a midships, the corresponding movements of the rudder being checked. (The functioning of the secondary steering positions is checked weekly as a matter of routine.)

By the Electrical Staff.—The gyro-compasses are started, the functioning of their systems is checked, and the Pelorus and steering repeaters are lined up.

The steering order transmitter is moved through its complete range and the repeater is checked.

The functioning of the rudder indicator and other electrical "tell-tales" is checked.

Sirens

Most warships are fitted with two sirens, and merchant ships usually with one. Many large ships may also be fitted with a mechanically operated fog-horn. These can be operated by steam or compressed air and controlled by a lanyard or electric press-button switch.

In peace-time sirens are tested before the ship gets underway, but in time of war they are not tested as this precaution might disclose that the ship is about to sail.

The operation of steam sirens by lanyard demands sureness and care, because water formed by condensed steam may choke them. Tension should be kept on the lanyard until the siren gives the required sound; if the lanyard is pulled in a series of jerks a distant observer may be confused between any sound he eventually hears and the puffs of steam he sees, especially if the sound is being blown away by a strong wind. Some ships are fitted with a mechanical or electrical device for working the siren at the correct intervals in fog.

Sound signals for use by ships are given in Chapter XVIII, "Rule of the Road".

Special Sea Dutymen

These consist of the quartermasters, boatswain's mates, and other seamen specially detailed to man the steering and other positions when the ship proceeds in and out of harbour. They include leadsmen, helmsman, telegraphmen, messengers, telephone operators and screw-flagmen. Their duties, with the exception of those of screw-flagmen, have already been explained in Volume I of this Manual.

Screw-flagmen are stationed aft, one on each side, within sight from the bridge, and each has a red and a white flag on a stave. Their duty is to indicate whether the water in the vicinity of the screws is clear or fouled (by wires or other gear) by raising respectively the white flag or the red flag. They are stationed only when the ship is working berthing or towing hawsers or other similar gear from aft, and they work under the orders of the officer in charge of the after part of the ship.

The call "Special sea dutymen" is sounded or piped about 15 minutes before the ship is due to get under way, and as necessary before she enters a harbour or an anchorage; it is a most important call and over-rides any other duty on which a man may be engaged. They are fallen out when the ship is clear of harbour or after she is berthed, and when clear of harbour they are relieved by the sea dutymen of the watch on deck, as detailed by the petty officer of the watch.

Before the ship is due to get underway the chief quartermaster is responsible that the steering position is manned in accordance with the ship's orders, and reports the fact by voice-pipe to the Officer of the Watch. He is also responsible that the leadsmen are ready for hand-sounding, that the sounding machines and booms are ready for use, and that the towed log is ready for streaming.

Conning and Steering Positions (Fig. 326)

Alternative positions from which the ship can be conned or steered are provided in all warships for use if the primary positions are put out of action. There are also alternative methods of steering for use if the main steering gear is damaged.

The following are the different conning and steering positions in H.M. ships, other than submarines :—

Bridge.—This is a general term used to describe any position in the upper portion of the bridge structure from which a ship is controlled and fought by her captain, or from which a fleet, squadron, or group of ships is controlled by its Flag or Senior Officer.

A bridge may be "open" (i.e. without a deckhead), or "closed" (i.e. completely enclosed).

Admiral's Bridge—the compartment designed for the use of an admiral when controlling his fleet or squadron.

Compass Platform (C.P.)—the compartment in the fore part of the upper bridge structure, designed as the ship's primary conning position. It may be open or closed.

Pilotage Position—an open position on the top deck of the bridge structure which is provided in a ship fitted with a closed compass platform to facilitate the handling of the ship when berthing or when manœuvring in confined waters.

Conning Tower—an armoured conning position separate from the compass platform.

Alternative Conning Positions—in capital ships several alternative conning positions may be provided, usually in "A" turret, on the fore side of the after funnel, and/or in the after superstructure. These are named after their positions in the ship, e.g., "'A' turret conning position", "after funnel conning position", etc., and one of them will be the "emergency conning position".

Emergency Conning Position (E.C.P.)—one such position is provided well separated from the compass platform. In larger ships it may be fitted with certain additional communications to enable the second-in-command to carry out his functions from it in action. In capital ships it is either the funnel conning position or a position in the after superstructure; in cruisers it is in the after superstructure; in aircraft carriers there are two, one to port and one to starboard; in destroyers it is either amidships or aft, and is also called the "emergency steering position".

Forward Steering Position (F.S.P.)—the compartment designed as the primary steering position in cruisers and larger ships.

Bow Rudder Steering Position—the position from which the bow rudder is controlled in certain large ships. This position may be sited in the "forward steering position".

Wheelhouse—the primary steering position in destroyers and small craft.

Steam (or Diesel) Steering Position—adjacent to the steam (or diesel)

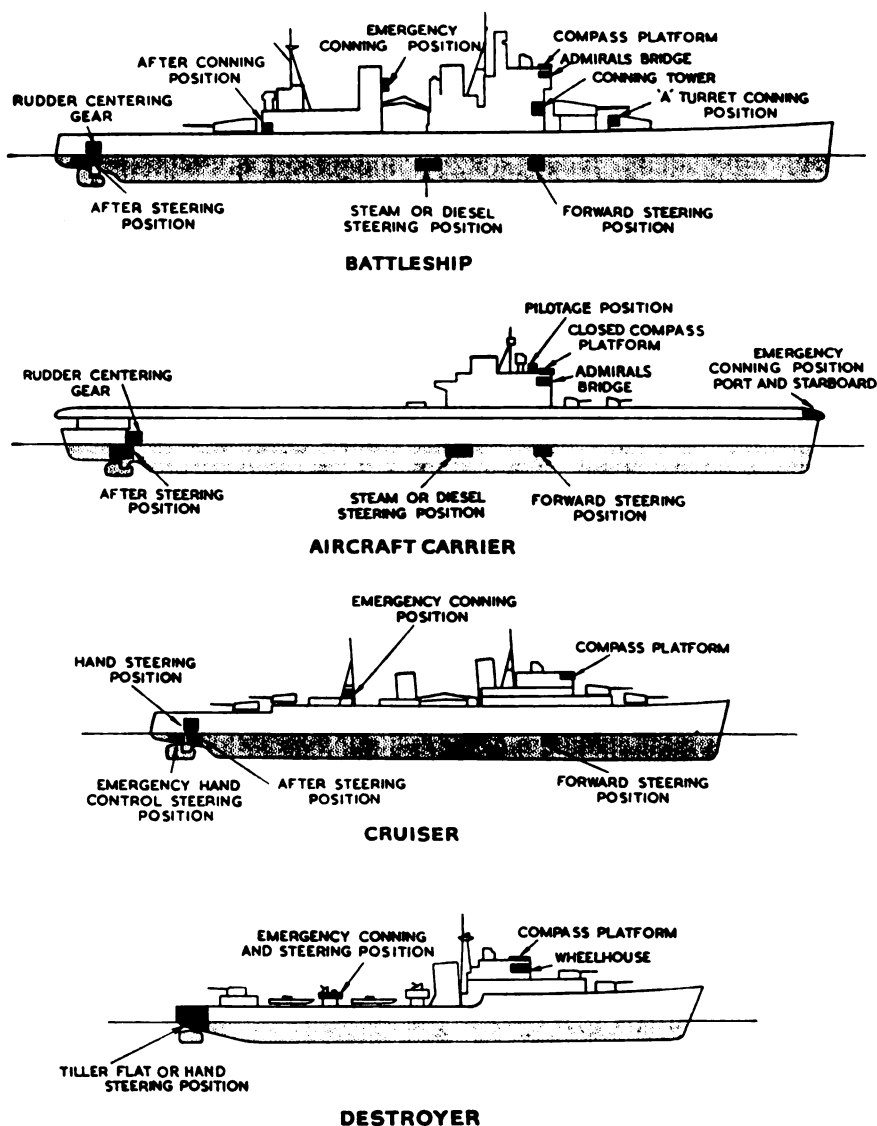


Fig. 326. Conning and steering positions

steering engine. If more than one such position is fitted they are known by their relative positions, *e.g.* "port steam steering position", and "starboard steam steering position".

After Steering Position—the mechanical wheel for local control of power-steering, fitted in a steering compartment aft. If more than one such position is fitted, these also are known by their relative positions, *e.g.* "port after steering position", and "starboard after steering position".

Hand Steering Position—the space which contains the hand pump for operating the rudder gears by hand. It is usually referred to as the "tiller flat" in destroyers.

Emergency Hand Control Steering Position—at the position of any of the power-steering-gear pumps where the latter are fitted with direct manual control for emergency use. Where more than one such position is fitted they are distinguished by the identification numbers or letters of the pumps concerned, or by those of the machinery spaces in which the pumps are fitted.

Each conning position is connected by telephone with each steering position and with the engine-room. Wheel orders can be transmitted from each conning position to each steering position by means of the wheel order transmitter, which is connected with the required steering position by means of a change-over switch situated in each conning position.

CHANGE-OVER OF CONNING POSITIONS

It is probable that the first intimation to be received at the forward steering position that the compass platform has been put out of action will be an order by telephone, such as "Emergency conning position in control; obey steering order receiver; man E.C.P. telephone". The quartermaster should then arrange for a continuous watch on the Emergency Conning Position telephone and obey all engine and wheel orders received from that position.

The forward position may, however, be the first to know of damage to the compass platform, in which case the quartermaster should immediately inform the E.C.P. and the engine-room by telephone or messenger.

CHANGE-OVER OF STEERING POSITIONS

The quartermaster will probably be the first to notice any failure of the steering gear, by experiencing stiffness or jamming of the wheel, or seeing the rudder and wheel indicators get out of step, or by getting incorrect readings of the telemotor gauges, and he should immediately report any such signs of failure to the Officer of the Watch. If the steering fails the ship will have to be steered by the main engines until an alternative method of steering is brought into use or the fault is made good. It may even be necessary to connect up one of the secondary steering arrangements and man one of the secondary steering positions. Until the ship is again under full steering control the "not under command" daymark should be hoisted.

As ships are differently equipped with alternative steering systems the procedure for their change over may vary considerably, and the following example is given only to convey the sequence of reports, orders, and actions, which may be involved in such a change over.

Q.M. to O.O.W. : "Ship not steering, Sir", or "Wheel jammed with ten degrees of port wheel on".

O.O.W. to Q.M. : "Steer by main engines. Steering gear broken down. Man after steering position".

Q.M. to Engine-room and After Steering Position (by telephone) : "Steer by main engines. Steering gear broken down. Man after steering position".

The quartermaster, without further order, goes to the after steering position, leaving the helmsman and telegraphmen in the forward steering position. The ship is then steered by altering the revolutions of the main engines by orders from the compass platform through the voice-pipe to the forward steering position, and thence by the revolution transmitters to the engine-room. The

helmsman takes charge of the forward steering position and is responsible for seeing that the required orders are passed.

In ships equipped with only one revolution transmitter it is the usual practice for one engine to maintain the last revolutions ordered before the breakdown occurred, and for the other engine to obey the revolution transmitter. As soon as possible the revolutions to be maintained by the former are confirmed by telephone from the forward steering position, and thereafter they are altered as necessary by telephone from the same position. Both engines continue to obey their respective engine order telegraphs.

When the quartermaster reaches the after steering position the procedure is continued as follows :—

Q.M. to Helmsman (by telephone) : “ Q.M. closed up in after steering position ”.

Helmsman to O.O.W. (by voice-pipe) : “ Q.M. closed up in after steering position. Sir ”.

Q.M. to Helmsman (by telephone) : “ Check compasses ”.

The quartermaster then checks his compass in the after steering position with the steering compass, and, if necessary, lines it up.

It should be noted that the forward steering position is used to pass orders from, and to receive reports for, the compass platform ; this relieves the Officer of the Watch of the necessity for handling a number of telephones and frees him to compete with the many problems confronting him in such an emergency.

The engine-room staff investigate the failure and decide which of the alternative means of steering should be employed. When this has been decided, the quartermaster reports to the Officer of the Watch by telephone (from the after steering position to the compass platform) the details of the breakdown and which of the alternative methods of steering is to be employed. This may entail the quartermaster manning another position.

The engine-room staff then connect up the secondary steering method selected, and the quartermaster reports as follows :—

Q.M. to O.O.W. (by telephone) : “ Ready to steer from the after (or other) steering position ”.

The Officer of the Watch then puts the change-over switch for the steering order transmitter to the required position, and orders a small alteration of rudder (say five degrees) by steering order transmitter to test the new system. This order is obeyed by the quartermaster at the after (or other) steering position. The rudder is then ordered a'midships by steering order transmitter, and if the Officer of the Watch is satisfied the procedure continues as follows :—

O.O.W. to Helmsman (by voice-pipe) : “ Steer from after (or other) steering position ”.

Helmsman to Engine-room and After (or other) Steering Position (by telephone) : “ Steer from after (or other) steering position ”.

The Officer of the Watch then gives the required wheel orders by steering order transmitter. Subsequently, whenever the ship is steadied on a course the quartermaster reports the course by telephone to the helmsman, who repeats it by voice-pipe to the Officer of the Watch. A continuous watch is maintained on the telephone between the forward and secondary steering positions.

REVERTING TO MAIN STEERING

When the fault in the main steering gear has been repaired, the following procedure may be carried out to revert to steering from the forward steering position :—

The engine-room staff report to the Officer of the Watch that the main steering gear has been repaired,

O.O.W. to Helmsman (by voice-pipe) : " Revert to main steering. Steer by main engines. Wheel a'midships ".

Helmsman to O.O.W. (by voice-pipe) : " 'Midships ", and, when he has centred the wheel, " Wheel's a'midships, Sir ".

Helmsman to Engine-room and After (or other) Steering Position (by telephone) : " Revert to main steering. Steer by main engines. Wheel a'midships ".

The quartermaster at the after (or other) steering position then centres his wheel, which centres the rudder. The engine-room staff disconnect the after (or other) steering position and connect up the main steering system to the forward steering position, and when all is ready, inform the helmsman. Meanwhile, the ship is steered by main engines as before. As soon as the secondary steering position is disconnected, the quartermaster reports the fact by telephone to the helmsman, and, without further orders, returns to the forward steering position and resumes his duties there. The Officer of the Watch puts the change-over switch for the steering order transmitter to the forward steering position.

Helmsman to O.O.W. (by voice-pipe) : " After (or other) steering position disconnected. Ready to steer from forward steering position, Sir ".

The Officer of the Watch then tests the main steering system by a small alteration of course, and, when satisfied, resumes the normal procedure for steering the ship.

O.O.W. to Helmsman (by voice-pipe) : " Steer from forward steering position ".

Helmsman to Engine-room and After Steering Position (by telephone) : " Steer from forward steering position ".

Steering Gear in H.M. Ships

Details of steering gear differ with the type and size of the ship, but it may be said that the gear is divided into two parts.

The first part consists of the steering wheel and transmission system, whereby the motions of this wheel are transmitted to some after position in the ship ; the second part is that which actually operates the rudder and whose movements are controlled by the first.

The telemotor system is used to convey the movements of the wheel as far as the tiller flat or steering gear compartment, wherein is housed the electro-hydraulic gear which turns the rudder. The following is a very brief description of the whole system and it should be read in conjunction with the simplified diagram on page 592.

THE TELEMOTOR SYSTEM

From Fig. 327 it can be seen that when the wheel is turned to port, both pistons in the pedestal mounting of the wheel are moved upwards, thus putting pressure on the telemotor fluid (glycerine and distilled water) in the

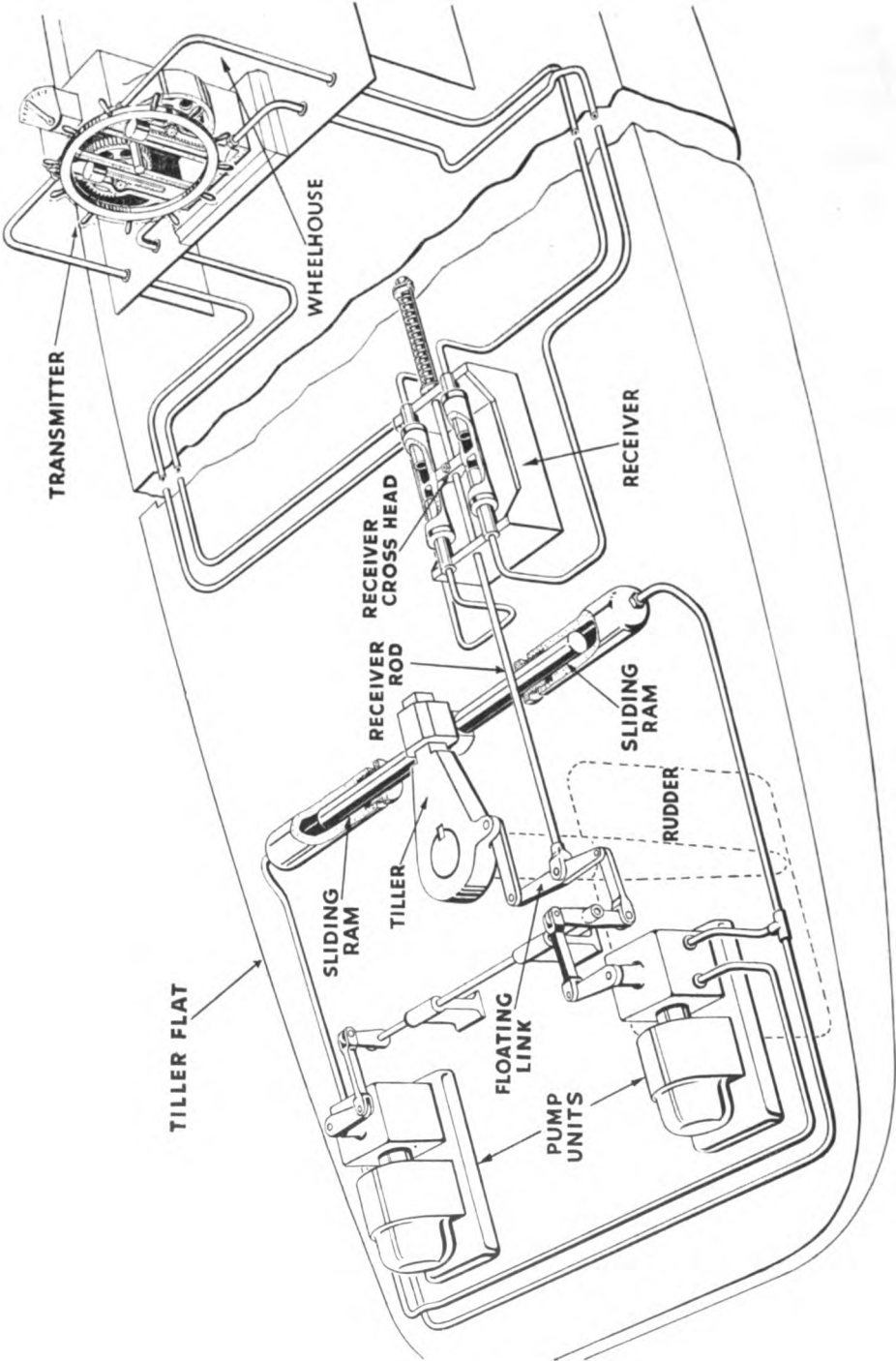


Fig. 327. The telemotor system

upper pipes. These pipes conduct the pressure to the "receiver" which is situated in the tiller flat, aft.

The receiver consists of two "floating" cylinders which move backwards and forwards over four fixed and hollow pistons, to the heads of which are connected the four pipes from the steering pedestal. Each cylinder is divided into two separate compartments, and the cylinders are joined together by a cross-head. Any change in the pressure of fluid in the two sets of pipes will therefore cause the cylinders to move backwards or forwards. The diagram shows the pressure being delivered to the forward compartment of each cylinder, and the two cylinders moving aft.

This movement is transmitted by means of a rod to a "floating link", the inner end of which acts for the time being as its fulcrum because it is connected by a rocker-arm to the tiller-head. The movement of the receiver rod is therefore transmitted by the outer end of the floating link, through link gear, to the arm which operates the valves of the hydraulic pump units.

The pump units (Hele-Shaw or Williams-Janney) are electrically driven at constant speed. They are connected by fluid filled pipes to the heads of two cylinders, in which works a sliding ram connected at its centre to the end of the tiller by means of a ball joint.

Depending upon which way the arms of the valves are moved, the pumps will put pressure on the port cylinder or the starboard cylinder, thus causing the ram to move in the required direction.

The diagram shows pressure applied to the port cylinder, which causes the ram to move to starboard, and as the ram is connected to the end of the tiller this moves the rudder-head clock-wise, thus putting on port rudder.

This movement would continue until the rudder is hard over were it not for the floating link connected to the tiller head. When the tiller begins to move, the fulcrum of this link is transferred to the end of the receiver rod, at its centre, and as the tiller head turns, the inner end of the link is moved aft and the outer end forward, thus centering the valves of the pump units. This equalises the pressure at either end of the sliding ram so that it stops moving, and the rudder thus comes to rest at the required angle.

The forward end of the receiver rod is attached to a spring which the movement of the rod subjects to compression or tension. The function of this spring is to centralise the receiver cylinders and thus return the rudder and steering wheel to their 'midships' position when pressure is removed from the spokes of the steering wheel.

When the steering wheel is turned to starboard, the whole system functions in the reverse direction.

Precautions While Steering

Move the wheel with a steady, even motion. On the top of the steering pedestal is the replenishing tank, and the fluid in this tank must not be allowed to fall below the glass gauge; the cock on the bottom of the tank must always be open when the steering gear is in use. Where the wheel tends to fly back to "'midships'" of its own accord it must *not* be allowed to do so; it should always be eased back instead. Pressure gauges are fitted to the steering pedestal to enable the quartermaster to see what pressure there is in each side of the system. While the wheel is being turned the side in use must not be allowed to register a pressure of more than 600 lb. per sq. in., which requires that the wheel should be turned gently. When the wheel is amidships the

gauges should read zero ; if for any reason they do not, the bye-pass valve provided should be opened, which allows the pressure on both sides of the system to equalise and will bring the rudder back a'midships.

Finally, any defect or unsteady working of the gear should at once be reported to the Officer of the Watch, and also to the engine-room.

CHAPTER XX

Ships' Compasses and Direction by Compass

The Gyro-Compass

THE gyro-compass functions on the principle that the axis of a perfectly balanced wheel, which is spinning at high speed and suspended in gimbals so that it is free to turn or tilt, will remain pointing in a fixed direction in space.

By mechanical means such a wheel can be made to seek the direction of true north and remain pointing in that direction. If a compass card is mounted on the gimbals of the wheel so that its north and south line is in line with the axis of the wheel, the result will be a gyro-compass from which any direction can be ascertained.

A ship's gyro-compass is a delicate and electrically operated mechanism which is very susceptible to shock and vibration, and is more bulky than a magnetic compass; it is therefore usually situated centrally in the hull of a ship and below the waterline, where it is afforded the best protection from the shock of gunfire and enemy action. When a gyro-compass has been started some time must be allowed for it to settle down, and a ship's gyro-compass should be started about five hours before it is required for use. Modern warships of cruiser size and above are equipped with three gyro-compasses; less modern or smaller ships may be equipped with only one or two.

By means of a system of electrical circuits and mechanisms, a gyro-compass can operate several "repeaters", which are situated in various parts of the ship as required for navigational or certain other purposes. These repeaters consist of a compass card mounted in a bowl containing their operative mechanisms, and, with certain limitations, they will indicate the same direction as the gyro-compass by which they are operated. Each repeater is fitted with a switch by which it can be electrically connected to one or other of the gyro-compasses, and each is fitted with a mechanical device by means of which its compass card can be rotated for the purpose of adjusting its reading to that of its gyro-compass.

It should always be borne in mind that a repeater may not be running, or that if it is known to be running it may not indicate the correct direction, for one of the following reasons:—

- (i) the gyro-compass to which it is connected is not running, or is not functioning correctly;
- (ii) the electrical circuit between the repeater and its gyro-compass is defective;
- (iii) the electrical switch on the repeater has not been made;
- (iv) the repeater has not been initially synchronised or "lined up" to indicate the same direction as its gyro-compass;
- (v) the repeater is out of step with its gyro-compass because of a fault in the repeater mechanism.

Before first using a repeater always ensure therefore:—

- (i) that the repeater is switched on to the correct gyro-compass;
- (ii) that the repeater is lined up with its gyro-compass.

It is also important to ensure that the gyro-compasses and their repeaters are functioning correctly by frequently checking the readings of repeaters and gyro-compasses with each other, or with some other indication of direction such as a magnetic compass, an astronomical observation, or known landmarks. Failure of a gyro-compass to function owing to some electrical fault will be indicated by the "gyro alarm system", in which electric bells are sounded and red lamps switched on in various control positions such as the main switchboard and the forward steering position.

GYRO ERROR

A gyro-compass may function correctly, but at the same time register a small but constant error known as "gyro error". If the gyro-compass indicates a direction which is numerically larger than the true direction, the error is described as "high", and conversely a numerically smaller reading than the true direction is described as "low".

All directions indicated by gyro-compasses should be corrected for any gyro error before they can be recorded as true directions, and conversely all true directions should be corrected for any gyro error before they are applied to the gyro-compass or its repeater.

To convert a true direction to a direction by compass, or *vice versa*, the following simple rules for applying the gyro error may be used:—

- (i) When converting true direction to direction by compass: *add* the gyro error if *high*, and *subtract* the gyro error if *low*.
- (ii) When converting direction by compass to true direction: *subtract* the gyro error if *high*, and *add* the gyro error if *low*.

Example 1:—

Ship's head by compass is 218° ;
gyro error is 1° high (subtract) ;
true ship's head is 217° .

Example 2:—

True course is 057° ;
gyro error is 1° high (add) ;
course to steer is 058° .

Example 3:—

Bearing by compass of an object is 176° ;
gyro error is 1° high (subtract) ;
true bearing is 175° .

TYPES OF GYRO-REPEATER

There are two main types of gyro-repeater fitted in ships, namely the "bearing repeater" and the "steering repeater".

The bearing repeater is always mounted in gimbals, and is situated on the compass platform (where it is known as the "Pelorus") and in other positions from which the ship is conned and navigated.

If the view of the horizon from the Pelorus is obstructed in any direction the Pelorus is said to be "wooded" in that direction. The Pelorus of most ships is wooded, when looking aft, by funnels and superstructures; a bearing repeater, known as a "wing repeater", is therefore fitted in each wing of the bridge, from which an unobstructed view can be obtained in the wooded directions of the Pelorus. These repeaters are mounted in gimbals on a bracket fixed to the bridge rails or bulwarks.

Steering repeaters are of two types. One is similar to the bearing repeater except that it is not mounted on gimbals and can be fitted in any desired position ; the other differs radically in its construction in that the compass card is represented by an endless tape mounted on rollers (see Fig. 328). The latter type will only show in its limited window the direction of the ship's head and up to about 15 degrees each side of it.

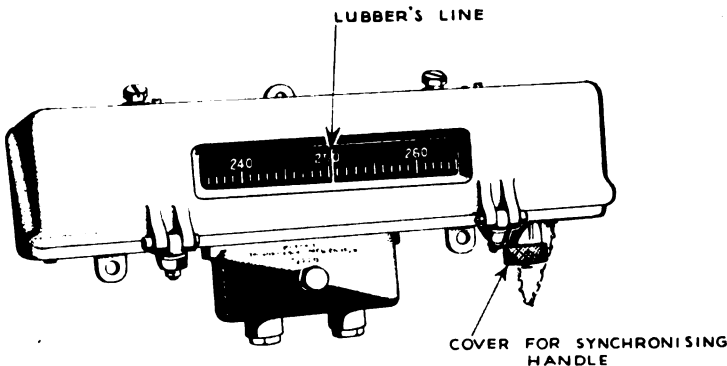


Fig. 328. Gyro-compass steering repeater

STEERING GYRO-COMPASS

Some ships are equipped with a small gyro-compass, situated in the forward or main steering position, for use in the event of a breakdown of the master gyro-compasses. It is electrically operated, and its mechanism is contained within its stand.

Magnetism and Direction by Magnetic Compass

MAGNETISM

The operation of a magnetic compass depends upon the principles of magnetism.

Certain minerals such as iron ores and lodestones have the property of attracting and repelling one another. This property is known as magnetism, and these substances are called "natural magnets". A magnet also possesses the power of attracting certain minerals such as iron or steel, and it may be attracted by them, and such substances are known as "magnetic substances"; magnetism can also be introduced into them, and they are then known as "artificial magnets". The nearer one magnet is to another, or to a magnetic substance, the greater is their magnetic influence on one another.

Magnetism cannot be introduced into wood or other vegetable substances, or into glass, brass, and copper ; neither can these exert any magnetic influences or be influenced by magnetic forces, and they are therefore known as "non-magnetic substances".

Anything possessing magnetic properties is said to have a red and a blue pole, and these are situated one at each of its two extremities, and around them the attractive and repellant forces of magnetism are particularly evident. If two magnets are brought together within the area of each other's magnetic influence, with the red pole or the blue pole of each adjacent, they will repel each other, but if the red pole of one is brought near the blue pole of the other they will attract each other.

Anything with magnetic properties will exert a magnetic influence over an area immediately around it. This area is known as its "magnetic field", and consists of curved lines of "magnetic force" which run between the two poles (Fig. 329). Any comparatively small magnetic article, such as a needle, when placed within a magnetic field will tend to align itself along these lines of magnetic force.

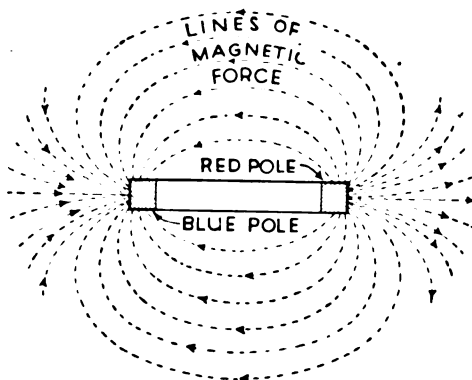


Fig. 329. Magnetic field of a magnet

Magnetism can be introduced into a magnetic substance by several different methods, of which the following are examples:—

- (i) by rubbing the substance with a magnet ;
- (ii) by hammering it ;
- (iii) by passing an electric current around it ;
- (iv) by allowing it to remain for a time in the field of a powerfully magnetised object (the magnetism it acquires is then known as "induced magnetism").

Magnetism is introduced into soft iron more easily than into steel, but steel will retain its magnetism much longer than soft iron.

TERRESTIAL MAGNETISM

The earth can be regarded as an enormous lodestone with its magnetic poles situated near the extremities of the imaginary axis around which it revolves, and these poles are known respectively as the North Magnetic Pole and the South Magnetic Pole. Some of the lines of magnetic force of the Earth's magnetic field run approximately northward and southward along the Earth's surface, from one magnetic pole to the other. A magnetised needle freely suspended or pivoted at its centre will come to rest pointing along the particular line of magnetic force which passes through its position, and with its north-seeking end pointing in a direction known as "north magnetic". The angular difference between the directions of north magnetic and true north at any place is known as the "variation".

Variation and Deviation

VARIATION

Unfortunately the positions of the magnetic poles do not coincide with those of the geographical poles ; in fact the North Magnetic Pole is at present (1952) in the extreme north-east of Canada. Furthermore, the lines of magnetic

force, known as "magnetic meridians", run very erratically instead of running directly between the magnetic poles, and the amount of variation at any place is governed by the vagaries of terrestrial magnetism and not by the difference in longitude between the place and the North Magnetic Pole. Also, the position of the North Magnetic Pole, and consequently the directions of the magnetic meridians, change slowly but progressively from year to year.

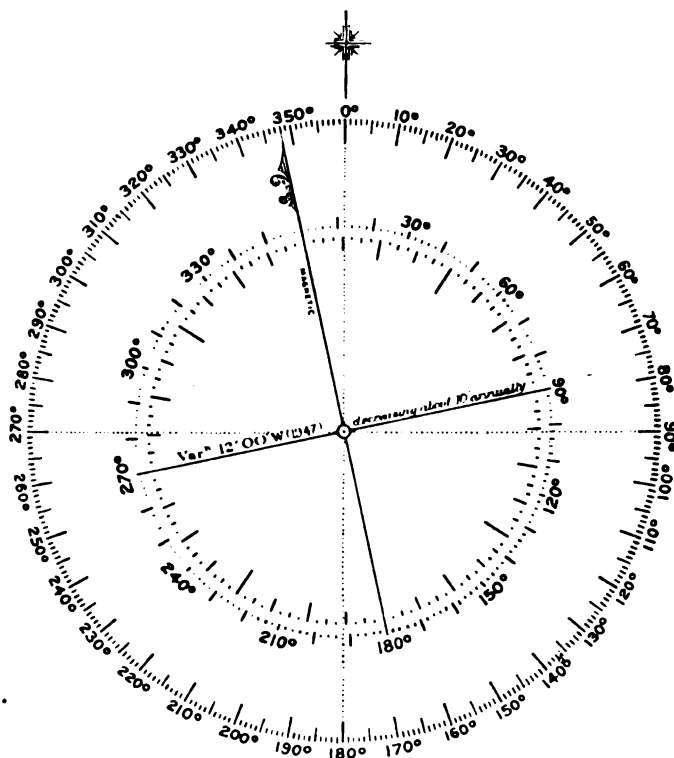


Fig. 330. Compass rose of a chart

The directions in which the magnetic meridians run, and their annual change, are accurately known, however, and the amount of variation at any place can be calculated with sufficient accuracy for most purposes of navigation. The variation at any place, together with its annual change, is indicated on the compass roses of charts (see Fig. 330), so that a magnetic direction can be converted to a true direction, or *vice versa*, by simple addition or subtraction.

If the direction of magnetic north from any place lies westward of true north the variation is said to be westerly, and if it lies eastward of true north the variation is said to be easterly. To convert a magnetic direction to a true direction, easterly variation is given a plus sign and westerly variation a minus sign; and to convert a true direction to a magnetic direction the signs are reversed. The following couplet provides a useful reminder for converting a true to a magnetic direction, and *vice versa* :—

*Variation east, magnetic least ;
Variation west, magnetic best.*

Example :—

	Magnetic Direction	Variation	True Direction
Position A	130°M	20°W (— <i>magnetic best</i>)	110° (Fig. 331(a))
Position B	090°M	20°E (+ <i>magnetic least</i>)	110° (Fig. 331(b))

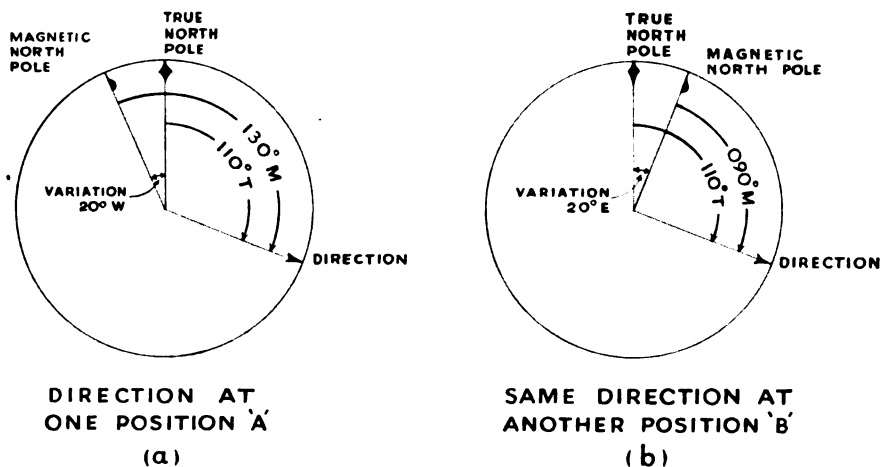


Fig. 331. Examples of variation

DEVIATION

While an iron or steel ship is being built she acquires magnetic properties from the hammering to which she is subjected during her construction. These properties are known as the ship's "permanent magnetism". Subsequently, the extent and strength of this magnetism may be changed considerably by large alterations or additions to her structure, or by large refits. A certain amount of magnetism will also be induced into a ship by the earth's magnetic field if she lies pointing in one direction for any length of time. This is known as the ship's "induced magnetism". Both the permanent and induced magnetisms will alter when a ship passes from northern to southern latitudes or *vice versa*. No two ships, even if they are of the same class and built alongside each other in the same port, will possess the same degree of magnetism.

The magnetic properties of a ship have a great influence on any magnetic compass placed in her, and their effect causes the compass to indicate a direction other than that of magnetic north. This error is known as "deviation", and its amount will vary with any changes in the magnetic properties of the ship.

Because of various peculiarities in the effects of a ship's permanent and induced magnetisms, the deviation of a magnetic compass will be different for different directions of the ship's head, and these differences may be considerable. Fortunately, although these effects cannot be entirely eliminated, they can be sufficiently reduced for the purposes of accurate navigation by means of corrector magnets, soft iron spheres, and the Flinders' bar.

Electricity also effects a magnetic compass if it is particularly strong or in close proximity to the compass. The magnetic compasses of ships which have been "degaussed" (an electrical method of rendering a ship immune from magnetic mines) are fitted with special compensating coils. Electric current to these compensating coils is automatically switched on when the degaussing system is in use, and switched off when not in use.

The method by which a magnetic compass is finally corrected is one of trial and error. The ship is turned (or "swung") through the various points of the compass, in the process of which the deviation for every direction of the ship's head is reduced to a minimum, and finally recorded on a "deviation card" which is kept in the vicinity of the compass for future reference (Fig. 332). This process is known as "swinging ship for compass adjustment". It is also necessary occasionally to check the deviations of the compass by swinging the ship through each point of the compass in turn and checking the recorded deviations; this is known as "swinging ship for deviation".

5. 387 (Revised—May, 1942)

TABLE OF DEVIATIONS

H.M.S. *EXAMPLE* At *MALTA* Date *25th APRIL 1947* Swinging Officer *C. LEE*

Ship's Head by Standard Compass	Deviation of Standard Compass		Comparison of Compasses with Standard				Ship's Head by Standard Compass
			Steering Compass		After Compass		
	D. G. On	D. G. Off	D. G. On	D. G. Off	D. G. On	D. G. Off	
N	2 E	2 E	2 W	1 W	4 E	NIL	N
NNE	NIL	1 W	1 W	1 W	1 E	3 E	NNE
NE	2 W	2 W	2 W	NIL	5 E	4 E	NE
ENE	1 W	1 W	1 W	1 E	5 W	2 E	ENE
E	1 E	2 E	1 W	1 E	8 W	4 W	E
ESE	1 E	NIL	1 E	3 E	9 W	3 W	ESB
SE	2 E	1 E	1 W	1 E	3 W	3 W	SE
SSE	3 E	3 E	1 E	1 E	3 W	3 W	SSE
S	1 E	1 E	1 W	1 W	NIL	6 W	S
SSW	2 W	NIL	1 E	1 W	4 W	2 E	SSW
SW	NIL	1 E	NIL	NIL	6 E	5 E	SW
WSW	1 E	2 E	2 E	1 W	2 E	NIL	WSW
W	3 E	2 E	1 E	NIL	6 E	8 W	W
WNW	2 E	NIL	2 E	1 W	4 W	6 W	WNW
NW	NIL	2 E	1 W	1 W	4 W	6 W	NW
NNW	1 E	NIL	NIL	2 W	3 W	1 W	NNW

Remarks:—AFTER COMPASS NOT FITTED WITH SPHERES OR CORRECTOR COILS

Fig. 332

Ships are swung for compass adjustment or deviation on the following occasions :—

- (i) if there is any doubt about the accuracy of the compass ;
- (ii) after refits or repairs, and after the ship has been lying in one direction for any length of time ;
- (iii) on large changes of the ship's position in latitude ;
- (iv) at regular intervals not exceeding one year.

Whenever possible the deviation of the compass is checked on individual courses by known transits of landmarks, or by astronomical observation.

When applying deviation to convert a direction by magnetic compass to a magnetic direction, or *vice versa*, the following should always be borne in mind :—

(i) that the deviation to be applied is that for *the direction of the ship's head* ;

(ii) that the deviation of one compass is different from that of another.

Deviation is applied in a similar manner to variation ; that is : when converting a compass direction to a magnetic direction, easterly deviation is given a plus sign and westerly deviation a minus sign ; and when converting a magnetic to a compass direction, the signs are reversed. The following couplet affords a useful reminder for applying deviation :—

Deviation east, compass least ;

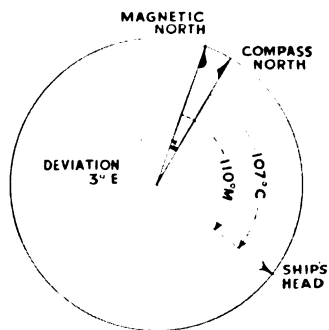
Deviation west, compass best.

The following examples show the manner of conversion.

Example 1 (Fig. 333(a)) :—

Ship's Head or	
Course, by Compass	107°
Deviation for 107°	3° E
	(compass least—add)

Ship's Head or	
Course, Magnetic	110°

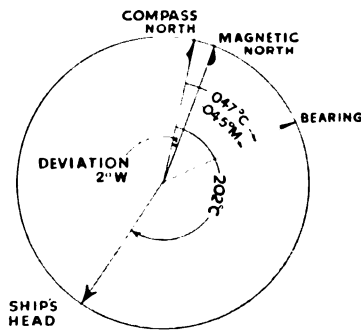


(a)

Example 2 (Fig. 333(b)) :—

Bearing of an	
object, by Compass	047°
Ship's Head	202°
Deviation for 202°	2° W
	(compass best—subtract)

Bearing of the	
object, Magnetic	045°



(b)

Fig. 333. Examples of deviation

Conversion of Compass and Magnetic Directions to True Directions

All charts are mapped in relation to true north and south, and therefore all courses are laid off and all bearings plotted as true directions. Directions obtained by magnetic compass have therefore to be corrected, first for deviation and then for variation, before they are marked on charts. Conversely, all true directions taken from a chart have to be converted, first to magnetic directions and then to compass directions, before they are applied to a magnetic compass. To avoid confusion between these different directions they are always recorded thus :—

- (i) true directions, by three figures without a suffix, *e.g.* 210° ;
- (ii) magnetic directions, by three figures with the suffixes " Magnetic " or " M ", *e.g.* 042° M ;
- (iii) magnetic compass directions, by three figures with the suffixes " Compass " or " C ", *e.g.* 223° C .

The following examples show the method of converting compass to true directions and *vice versa*.

Example 1 :—

A ship is ordered to steer a course of 358° . What is the compass course to steer if the variation is 20° W ?

True course	...	=	358°
Variation	...	=	20° W (<i>Magnetic best—add</i>)
Magnetic course	...	=	018° M ($378-360$)
Deviation for N.N.E. ($022\frac{1}{2}^\circ$)	=	3° E (<i>Compass least—subtract</i>)	
Course to steer		=	015° C .

Example 2 :—

The bearing of a lighthouse taken from a ship steering 160° C is 002° C . What is the true bearing of the lighthouse if the variation is 7° E ?

Compass bearing	...	=	002° C
Deviation for course S.S.E. ($157\frac{1}{2}^\circ$)	...	=	3° W (<i>Compass best—subtract</i>)
Magnetic bearing	...	=	359° M ($362-3$)
Variation	...	=	7° E (<i>Magnetic least—add</i>)
True bearing of lighthouse	=	006° ($366-360$)	

Compass Equipment

COMPASS COMPARISON DISC

The " total error " for a particular magnetic compass is the sum of its deviation and variation for the direction in which the ship's head is at the time. To facilitate the conversion of compass directions to true directions, and *vice versa*, a " compass comparison disc " is provided (see Fig. 334). This consists of two compass cards, pivoted one on top of the other, on which is set the total error for a particular direction of the ship's head ; the true direction is then read at a glance. It should be borne in mind that the total error will change with a change of direction of the ship's head, because of the change in deviation.

BEARING PLATES

Where a " standard " compass is wooded " bearing plates " are fitted in the wings of the bridge, from which a view of the wooded directions can be obtained. A bearing plate is mounted on gimbals in the fore-and-aft line of the ship, and consists of a compass card which can be rotated within a relative bearing ring and to which an azimuth circle can be fitted. Before taking a bearing with a bearing plate it must be lined up with the standard compass.

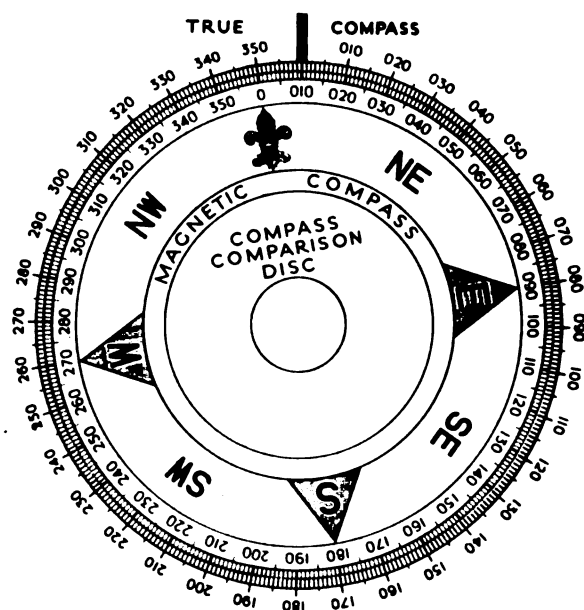


Fig. 334. Compass comparison disc

TRANSMITTING MAGNETIC COMPASS

Some craft may be equipped with a special type of magnetic compass which, like the gyro-compass, is capable of operating repeaters by electrical means, and the master magnetic compass can therefore be fitted in a position where it is least affected by the vessel's magnetic properties. With this type of compass the variation for the area in which the vessel is operating may be set on the repeaters, and allowance need only be made for deviation.

AZIMUTH CIRCLES

By means of the azimuth circle a view of a distant object can be obtained simultaneously with that of the relevant degree of the compass card, and so its bearing can be taken. The azimuth circle consists of a ring which can be rotated around the top of the compass and to which is fitted a hinged prism. Shades are provided to eliminate glare when taking bearings into the sun, and a mirror is provided for use when taking bearings of stars.

To take a bearing of an object at or near the level of the horizon, rotate the azimuth circle until the centre of the compass card, the "V" sight on the prism, and the object, are all on the line of sight. Now tilt the prism until the reflected view of the edge of the compass card can be seen in it, taking care while doing so to keep the card horizontal. The point at which the line engraved on the face of the prism cuts the reflection of the compass card indicates the bearing of the object by compass.

Each azimuth circle is designed for use with a certain pattern of compass, so that aiming errors are eliminated when taking bearings. It is therefore important to ensure that the correct azimuth circle is fitted to a compass.

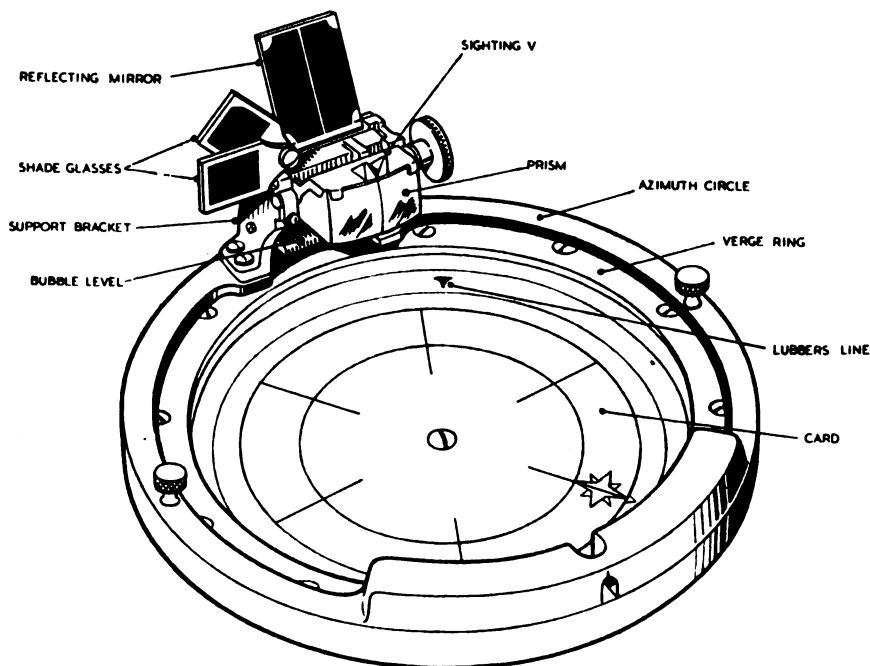


Fig. 335. An azimuth circle

It must be appreciated that azimuth circles are finely adjusted and so must be handled with care. Whether a circle is correctly adjusted for giving accurate results can easily be checked by following the printed instructions affixed to the lid of its stowage box.

STEERING PRISM OR MAGNIFIER

To enable the helmsman to see the ship's course easily while standing at the wheel, where he may be up to three feet distant from the compass, "steering prisms" or "magnifiers" are provided to give him an enlarged and reflected view of the lubber's line and the card in its vicinity.

GYRO-COMPASS SWITCHES

Gyro repeaters can be operated from either of the master gyro-compasses by means of a change-over switch. This switch is sometimes incorporated in the gyro-compass repeater panel in the gyro-compass room, but for the more important repeaters it is usually fitted as a separate unit near the repeater itself.

It is necessary to ensure that the switch is fully made, one way or the other, or faulty transmission will result. It must also be appreciated that if the switch is put over from one position to the other the repeater will require re-synchronising.

Where only one master gyro-compass is provided the change-over switch is replaced by an "on-and-off switch."

LIGHTING ARRANGEMENTS

Repeaters in open positions, and magnetic compasses other than boats' compasses, are illuminated at night by electric lamps ; in the former the lamps are inside the repeater, and in the latter they are in the binnacle.

Ship's binnacles are also fitted with oil lamps as a secondary system of lighting for use in emergency. Care should be taken that these oil lamps are trimmed, filled, and ready for use.

Boats' compasses are fitted with oil lighting only.

Supply and Maintenance of Compasses

ARRANGEMENTS FOR OBTAINING COMPASS EQUIPMENT

All compasses and compass equipment, both gyro and magnetic, are classed as "sea stores". This means that stocks are held, under the Director of Stores at the Admiralty, by Naval Store Officers at Dockyard Ports and other Naval Depots, and also that each compass and item of its equipment has an Admiralty pattern number assigned to it.

In the *Rate Book of Naval Stores* will be found a list of all types of compass and compass equipment, together with the pattern number and a brief description of each. The following extracts indicate the value and use of the Rate Book to ensure that the correct equipment required is demanded.

<i>Pattern No.</i>	<i>Description</i>
0195A	Compass, ship's, without Azimuth Circle, 8½ verge, gimballed fore-and-aft.
190	Binnacle, ship's, for compasses Patterns 195A and 0195A, complete with corrector coil unit, Pattern 896, and terminal box, Pattern 897.
1950	Circle, azimuth, for compasses, Patterns 195A, 0195A, and 195 T.A.
1951	Prisms, steering, for compasses, Patterns 195A and 0195A.

In a ship all the compass equipment is obtained by a "Demand Note" from the Naval Storekeeping Officer of the ship to the appropriate Naval Store Officer, and it is issued by the former officer on charge to the officer who requires it, *e.g.* the Navigating Officer, Electrical Officer, or Gunnery Officer. Ships can only demand equipment according to an approved allowance, laid down in what is known as the "*Ship's Establishment of Stores*"—B.R.358.

Gyro-compasses being "sea stores", the authority for their repair is a *Requisition for Repair of Sea Stores*, and not an entry in the ship's *Defect List*.

RESPONSIBILITY FOR ADVICE AND ASSISTANCE

The Director of the Compass Department, Admiralty Compass Observatory, Slough, Bucks, is responsible to the Board of Admiralty for advising and assisting ships in keeping their compass equipment efficient. Difficulties in connection with compasses, and suggestions for their improvement, should therefore be referred to him.

In Naval Dockyards the departments primarily responsible for the adjustment of compasses and making good their defects are the Electrical Department for gyro-compasses, and the Captain of the Dockyard's Department for magnetic compasses.

In ships the Electrical Officer is responsible for the performance of the gyro-compasses, and the Navigating Officer for that of the magnetic compasses.

At Royal Dockyards at home and at large dockyards abroad a resident representative of the Director of the Compass Department is available to advise on gyro-compass matters. He is known as the Superintendent, Gyro-compasses.

CHAPTER XXI

Measurement of Speed and Distance

Sea Measurements

1 fathom	= 6 feet or 2 yards ;
1 cable	= 608 feet, or roughly 200 yards or 100 fathoms ;
10 cables	= 6,080 feet, or 1 sea mile, or roughly 2,000 yards ;
1 sea or nautical mile	= 6,080 feet, or roughly 2,000 yards ;
1 league	= 3 sea miles. (This measure is now obsolete) ;
1 knot	= 1 sea mile per hour. A knot is a measure of speed only, and must never be applied to distance.

Dutchman's Log

This is probably the oldest and simplest method of measuring the speed of a ship, and is based on the fact that by observing the time taken for the ship to pass a floating and stationary object close alongside, the speed of the ship can be calculated.

A hand is stationed in the eyes of the ship with several pieces of wood, and at intervals he throws one overboard, well forward and outboard, so that it will float aft well clear of the ship's side. Two observers are stationed, one forward and one aft, as far apart as possible, and the distance between them is accurately measured. Each observer is equipped with an open sight (such as can be fashioned from a broom handle and three nails) which is trained exactly on the beam. The interval of time which each piece of wood takes to pass from one observer to the other is accurately noted by stop-watch, and the speed of the ship is then calculated with reasonable accuracy from the mean of five such intervals.

Example :—

Distance between observers is 420 feet ;

Mean interval of time for 5 runs is 35 seconds ;

$$\text{Speed of ship} = \frac{420}{35} \times \frac{60 \times 60}{6080} = 7.1 \text{ knots.}$$

Hand Log

This method was used in the days of sail, and from it is derived the term "knot" as the unit of a vessel's speed. It can be used only for slow speeds, but it is very simple and may be of use in case the mechanical means of measuring the ship's speed fails.

The log line should consist of 150 fathoms of lead line, well stretched, marked while wet, and made up on a hand reel. To its end is attached, by means of a "crow's foot", the "log-ship", which is a piece of wood shaped like a sector of a circle ; the arc of the log-ship is weighted to enable it to swim square and upright. Two legs of the crow's foot are standing, and the third is secured by

a peg which withdraws when the line is jerked, thus allowing the log to float flat in the water and then be handed (*i.e.* hauled in) with the least resistance.

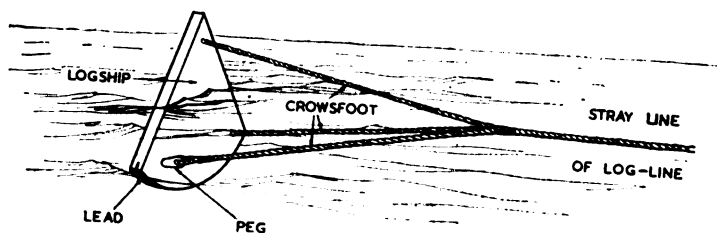
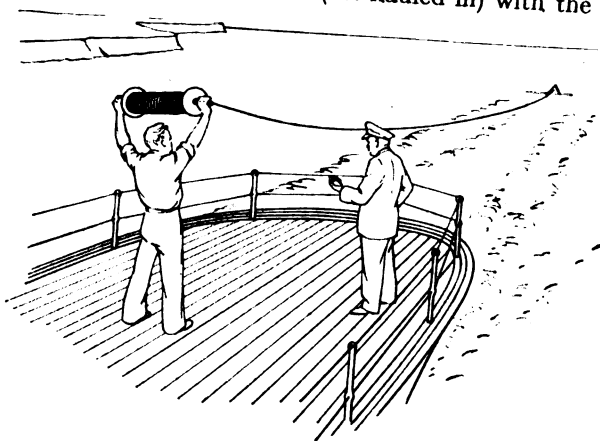


Fig. 336. Hand log

On the log-ship being thrown overboard it grips the water and remains stationary, and as the ship moves ahead from it the line is pulled off the reel; a sufficient quantity of "stray-line" is allowed to run away to enable the log-ship to clear the wake and get a sufficient hold of the water before measurement begins. The line is then allowed to run out freely for a certain interval of time, and the amount of line thus run out will give an indication of the speed of the ship.

The length of line required to represent one knot must be in the same proportion to a sea mile as is the interval of time selected to one hour. The common practice is to select 28 seconds for the interval of time, for which a length of 47 feet 3 inches must be allowed on the log line for each knot, and 90 feet is usually allowed for the length of stray line.

If the ship is moving at over 8 knots, the interval of time should be halved to 14 seconds, and the measurement of the log line should be doubled.

The log-line is marked with a piece of white bunting at the end of the stray-line, to mark the beginning of the measurement, and thereafter with:—

- one knot to represent every half mile;
- a piece of leather to represent the first mile;
- two knots to represent 2 miles;
- three knots to represent 3 miles;
- four knots to represent 4 miles; and so on.

Estimation of Speed by Revolutions

The speed of a screw-propelled ship can be estimated from the number of revolutions of her propeller shafts during a given interval of time. A table, known as the "revolution table", is made out for each ship from the results of actual trials. It gives the revolutions per minute of the propeller shafts required for each knot of the ship's range of speed in smooth water, when the draught of the ship is normal and the bottom clean. In freighters a table can be made out for different states of draught. The ship's speed is usually estimated by such tables from the mean revolutions per minute during one hour's steaming. These tables are a good guide for estimating the speed through the water if due allowances are made for any variation from normal draught, the state of the ship's bottom, and the effect of wind and sea, but it is usually easier to estimate these allowances accurately for a large ship than for a small one.

Towed Logs

The principle on which these logs work is that, when towed through the water, a specially constructed "rotator" will revolve at different rates at different speeds of tow. The revolutions of the rotator are transmitted by the log line to a counter mechanism which registers the distance run.

There are several types of this log in use at sea, but the one described here and illustrated in Fig. 337 is the Trident Log, as supplied to ships of the Royal Navy.

TRIDENT LOG

This log has a four-bladed bronze rotator at the head of which is a fixed eye connected by the log line to the counter mechanism, called the "register"; this is usually situated right aft and mounted on a guardrail stanchion, or on the taffrail, but sometimes it is streamed from a special boom fitted on the wing of the bridge. The register is electrically connected to a "repeater", usually situated in the charthouse.

The register and the repeater are equipped with similarly graduated dials and pointers. The large dial records the distance run in miles, from one to 100; one of the small dials records tenths of a mile run, and the other records hundreds of miles run, from 100 to 500.

The log line is $1\frac{1}{8}$ -inch special, plaited line, which can be spliced only by the makers. It is supplied ready for use, fitted with a hooked eye at one end and with the other end bare, in lengths of 70, 65, 50 and 40 fathoms. Between the register and the log line is fitted a wheel called the "governor", which is fitted with a short length of 2-inch special plaited line with a hooked eye at its foremost end. The governor with its line is hooked into the eye of the register, and the eye of the log line is hooked into the eye of the governor. The after end of the log line is passed through the end of a special link, called a "fish" or a "shell", and then out through a hole in its barrel; it is secured from unreeling with a figure-of-eight knot which is then tucked back into the barrel of the fish. The barrel is grooved inside to prevent the line from turning. The rotator is connected to the fish by a short length of 2-inch plaited line, spliced at both ends and supplied ready fitted. The fish thus enables the length of the log line to be adjusted without interfering with the spliced end.

The accuracy of these logs depends largely on the depth at which the rotator is run, and therefore upon the speed of the ship and the length of the log line.

The following lengths of log line have been found suitable for normal vessels :—

- 40 fathoms at speeds of about 10 knots ;
- 50—55 fathoms at speeds of about 15 knots ;
- 65—70 fathoms at speeds of about 18 knots and over.

These logs will not register accurately at slow speeds and they are therefore not streamed until the ship is clear of harbour ; their accuracy varies also with the type of ship. For these reasons their individual errors must be recorded for varying speeds by trial in one of two ways :—

- (i) from a run between two points at a known distance apart, due allowance being made for the tidal stream or current ; or
- (ii) from a run over a measured distance, with and against the tidal stream or current.

The log line is liable to stretch appreciably, and should therefore be frequently measured. Because of its plaited construction, deterioration is difficult to detect and the line should be carefully inspected from time to time.

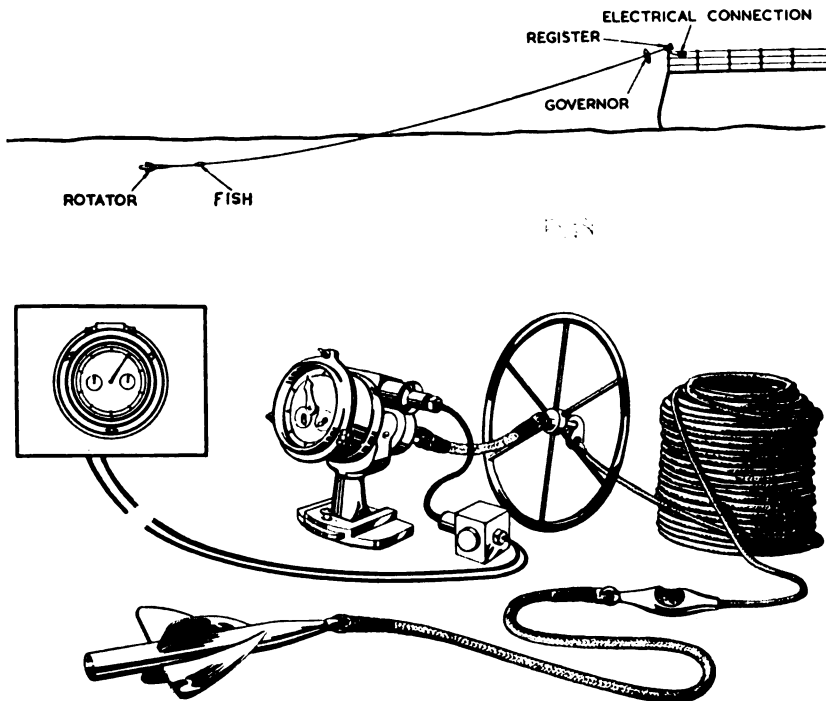


Fig. 337. Towed log (Trident type)

If the log under-records for no apparent reason it is a sure sign that it is foul or has been damaged, and it should at once be handed. Great care should be taken of the rotators, especially when streaming or handing the log, as any distortion may considerably affect the accuracy of the log.

Disadvantages of this type of log are that :—

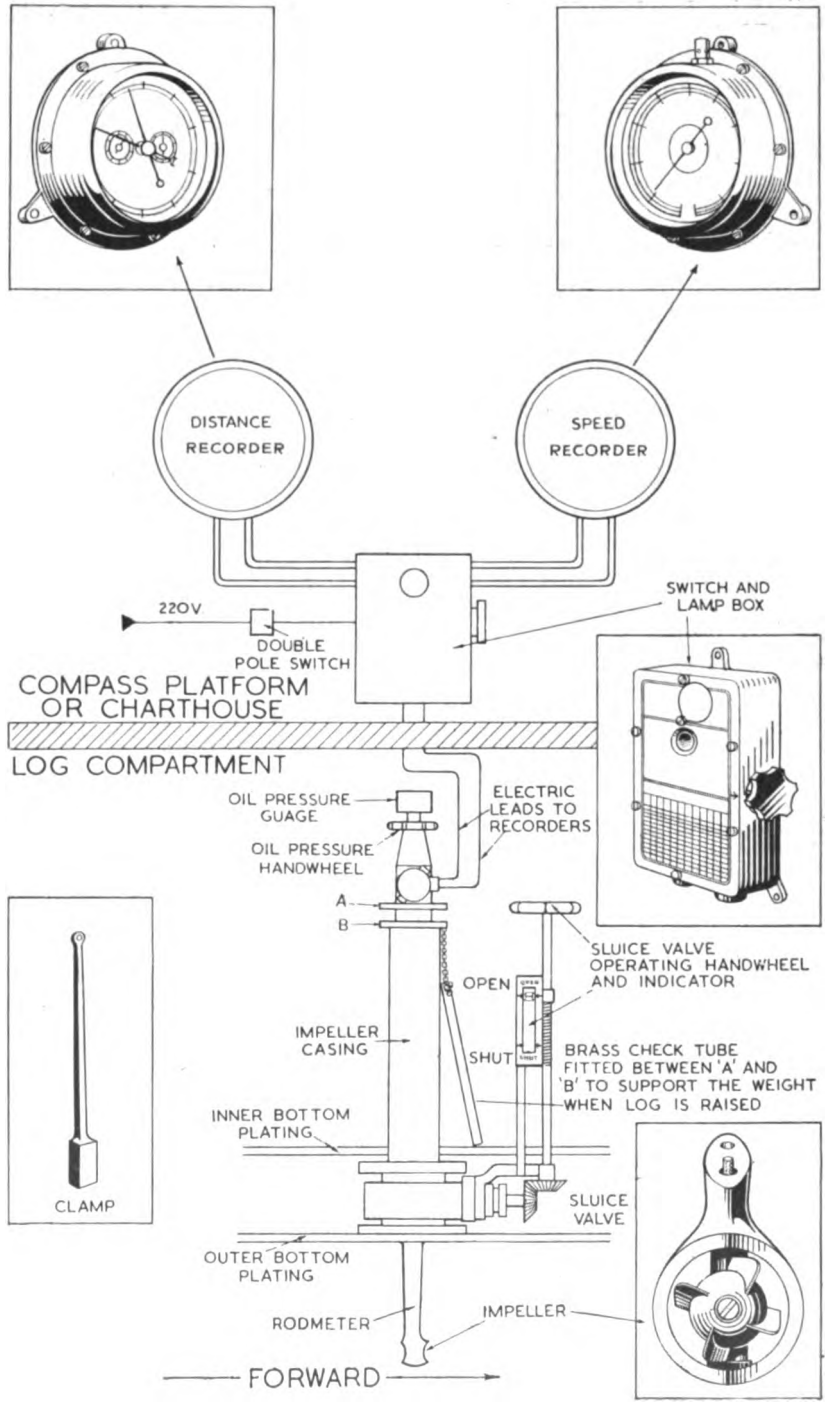


Fig. 338. Chernikeeff log

- (i) the rotator is liable to be fouled or damaged by flotsam such as seaweed and timber ;
- (ii) it must be handed if the ship stops or goes astern
- (iii) it is inaccurate in a heavy following sea ;
- (iv) it attracts large, predatory fishes, and losses of rotators from this cause are frequent in tropical waters.

To Stream the Trident Log.—Ship the register, set the pointers to zero, and connect up the electric cable from the deck connection. Hook the governor to the register, tail forward. Select the correct log line for the ship's speed and hook its forward end to the governor. Lead the log line, from outboard, in through the after fairlead, flake it down along the poop or quarterdeck in as long fleets as possible, and secure it to the link and rotator. The log should not be streamed or handed at speeds of over 10 knots, otherwise the strain on the line becomes too great, and it should always be streamed from the windward quarter. To stream the log pass the rotator out from the fairlead, lower it into the wake, and then pay out the log line, keeping it under control and taking care that no undue strain is placed on the register or its mounting.

To Hand the Log.—Before starting to hand the log, note the time and the reading of the register. Stop the governor, grasp the log line abaft it, and recover a sufficient amount to pass the bight through the fairlead and belay it on the bight. Disconnect the log line from the governor, and the governor from the register. Then run the log line in, veering the first end astern from the opposite fairlead at the same time to take the turns out of the log line. Recover the rotator with care and then haul in the log line streamed from the opposite fairlead. Wash the rotator in fresh water, dry it and smear it with light oil, wipe over and dry the governor and register before stowing them away, and stop up the log line in bights to dry.

Chernikeef Log (Fig. 338)

This log is fitted in the bottom of the hull, near the pivoting axis of the ship. It consists of an "impeller" (which is a type of water-wheel), mounted on an arm called the "rod-meter" which projects downwards about 13 inches from the outer bottom plating. The number of revolutions of the impeller gives the distance run by the ship, and is electrically recorded in "recording units" which are usually fitted in the charthouse and on the compass platform.

The rod-meter is a tube through which pass the electric leads connecting the impeller at its lower end with the recording unit, and it is mounted in a water-tight gland fitted in the hull which is closed by a sluice valve. The gland and sluice-valve allow the rod-meter and impeller to be withdrawn inside the hull for inspection and adjustment.

The impeller is mounted on bearings fed by oil under pressure from the top of the rod-meter. It is important that the pressure of oil should be maintained above 17 lb. per sq. inch when the rod-meter is down, in order that water shall not seep into the bearings and affect the working of the impeller. A pressure gauge is fitted on the top of the rod-meter, and the oil pressure can be controlled by a handwheel situated just below it.

As it revolves the impeller operates a spring contact which, by electrical means, passes 400 impulses every mile (or one every 15.2 feet) to the recording unit.

The components of the recording unit consist of a "lamp-box" and switch, a "distance recorder" and a "speed recorder".

The switch starts and stops the electrical mechanism and should never be made until it has been ascertained that the rodmeter has been lowered.

In the lamp-box is a blue lamp which records the impulses by burning momentarily for each impulse. The speed of the ship is ascertained by timing 21 flashes of the lamp and comparing this time with the speed table engraved on the lamp-box. The regularity or otherwise of the flashes gives a good indication whether the equipment is functioning correctly.

The distance recorder is an electrically controlled counting mechanism. The large red pointer indicates tenths of a mile from 0 to one mile ; the large black pointer indicates miles from 0 to 100 ; the small left hand dial indicates hundreds of miles ; and the small right hand dial indicates thousands of miles, from 1,000 to 10,000.

The speed recorder incorporates an electrically controlled clockwork mechanism, the pointer of which indicates on the dial the speed of the ship in knots. If this recorder fails to function the fault may lie in the clock mechanism.

The underwater shape of ship's hulls differs considerably, and each log should be calibrated for the ship to which it is fitted. Errors of recording can be corrected by altering the pitch of the blades of the impeller by means of a special clamp. The blades should be fitted into the clamp one by one, and the pitch of each be altered by the required percentage, as indicated by the appropriate marking on the bottom of the clamp. The blades should be slightly over-corrected and allowed to settle to their required position in the clamp, because they are springy and tend to return to their original shape.

The routine for starting the log is as follows :—

- (i) Obtain permission from the Officer of the Watch to enter the "log compartment".
- (ii) Open the sluice-valve by means of the handwheel until the pointer indicates full open.
- (iii) Remove the brass check tube, push the log fully down and at the same time check the oil pressure in the impeller bearing and adjust it to read over 17 lb. per sq. in.
- (iv) Make the main switch.
- (v) Make the lamp-box switch and check the regularity of the flashes.
- (vi) Press the switch to start the clock in the master speed recorder.

The routine for stopping the log is as follows :—

- (i) Break the lamp-box switch and the main switch.
- (ii) If the rodmeter is to be raised pull the log up to its full extent and insert the check tube to take its weight.
- (iii) Close the sluice valve.

The rodmeter should be housed before the ship comes to a berth, and also before streaming paravanes.

Details of maintenance routines can be found in the handbook supplied by the makers.

Pitometer Log

This log is fitted in the ship's bottom, and works on the principle that the pressure exerted on it by the water varies with the speed of the ship. Two types are now (1949) provided in the Royal Navy, namely Type M.A.3 for ships larger than a destroyer, and Type D for destroyers and smaller vessels.

TYPE M.A.3

A bronze rod of oval cross-section, called the "rod-meter", is fitted in the bottom of the hull in a water-tight gland and provided with a sluice-valve, as in the Chernikeeff log, to enable it to be extended from, or withdrawn into, the hull. The rod-meter, when extended, projects about three feet below the bottom of the hull so that its end is clear of the disturbed water close to the outer bottom plating.

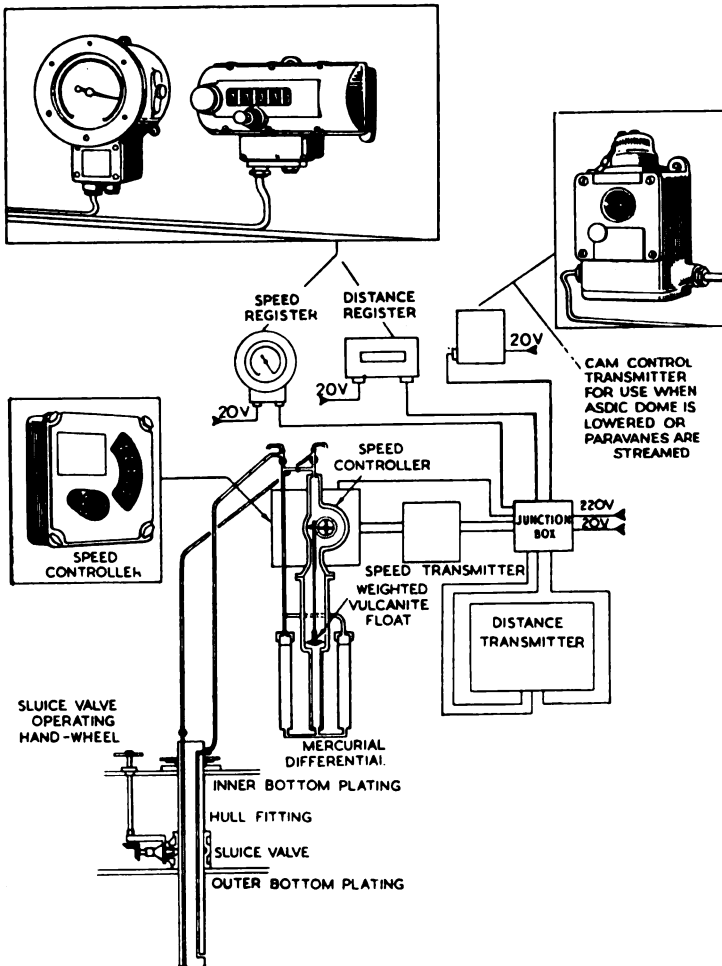


Fig. 339. Pitometer log (type M.A.3)

In ships fitted with an "Asdic dome" a "cam-control unit" is incorporated in the system, because the former, when lowered, affects the flow of water past the rod-meter and thus causes it to register incorrectly. Paravanes when streamed may also cause the log to register incorrectly. When the log is first fitted in the ship exhaustive trials are therefore carried out at all speeds over a measured distance with the Asdic dome housed and lowered, and with and without paravanes streamed, and special cams are cut for the ship and fitted in the "controller", for use when the dome is housed and lowered, and for when

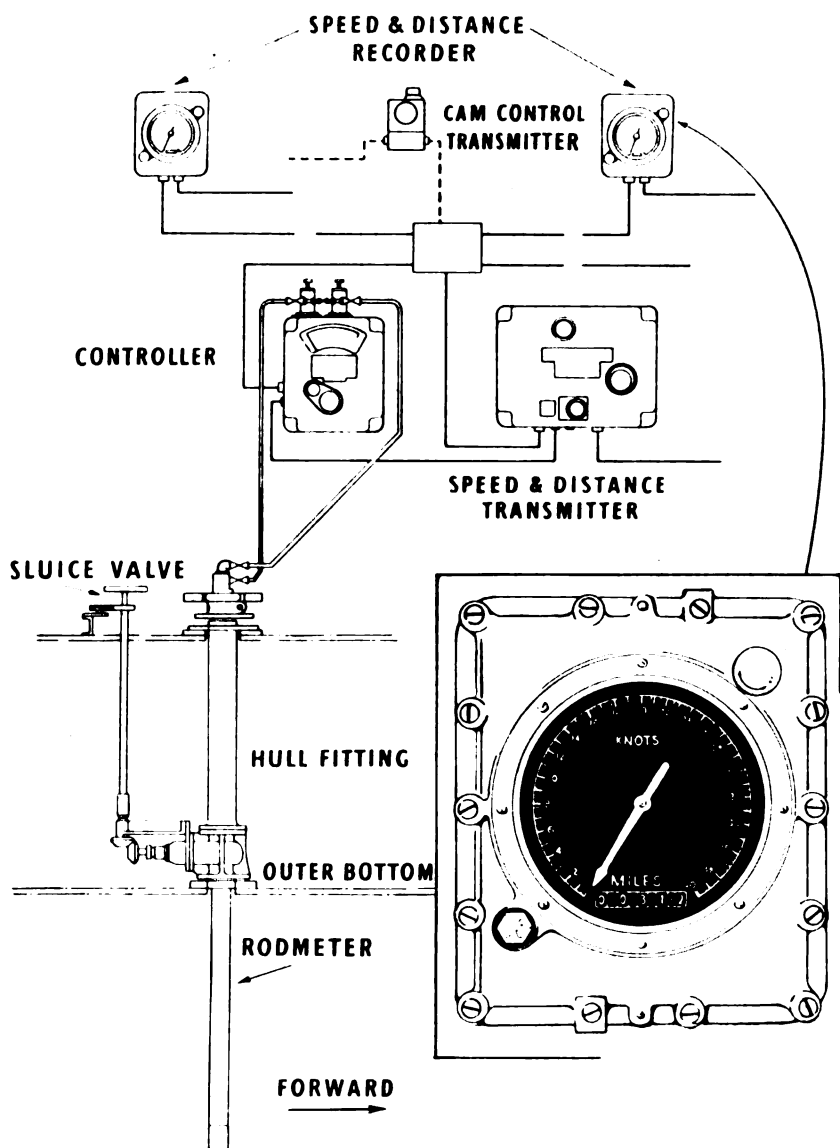


Fig. 340. Pitometer log (type D)

paravanes are streamed. The cams can be brought into operation by means of the "cam-control transmitter" situated on the compass platform; this box-shaped instrument has a screwed cap on its top; beneath which is a small handle, and turning the handle in the required direction disconnects one cam and connects another, the position of the cams being recorded on a small dial on the front of the instrument.

Large modern ships are fitted with two rodmeters which are so placed that they are unaffected by any retractable hull fittings situated before them, and in such ships a cam control unit is therefore unnecessary.

The rodmeter is bored longitudinally with two holes, of which one called the "impact pipe" has its mouth facing forward, and the other called the "static pipe" has two mouths, one on each side of the rodmeter. The upper end of each pipe is connected to a "mercury differential system", by which the difference of water pressure in the two pipes is measured; both pipes register the pressure of water at the depth at which they are situated, but the impact pipe also registers the additional pressure caused by any ahead movement of the ship.

By means of an electric mechanism, this difference of pressure is transmitted through a "speed controller" to two master transmitters, called the "master speed transmitter" and the "master distance transmitter", the mechanism of the latter being controlled by a self-winding clock. The transmitters are connected by electrical means to "speed recorders" and "distance recorders" respectively; these are situated in different parts of the ship, one of each type being in or near the chart-house.

In cruisers and larger ships two logs are usually fitted, either of which can be connected to the receivers by means of a change over switch, thus providing a spare log should one of them fail to function.

The routine for lowering and raising the rodmeter, and for starting and stopping the log, is given in the maker's handbook supplied to each ship. Before getting under way the counter mechanism of the distance receivers should always be set to zero.

Permission should be obtained from the Officer of the Watch before entering the log compartment at sea.

TYPE D. (Fig. 340)

The chief differences between this log and the Type M.A.3 are that a bellows type of differential system is fitted instead of the mercury system, and that "combined speed and distance receivers" are fitted instead of separate speed and distance receivers.

The counter mechanism in the combined speed and distance receivers cannot be reset to zero. Before getting under way the distance recorded on the receivers should therefore be noted in the ship's log.

The routine for working the Type D. log is included in the maker's handbook supplied to each ship in which the log is fitted.

Distance Meters

These are small hand instruments generally used on the bridge for obtaining ranges of navigational marks and nearby ships, for navigation and station-keeping purposes, respectively.

They comprise the Stuart's Distance Meter, the Waymouth-Ross Sextant Rangefinder, and the Small-base F.T. Rangefinders. The Stuart's Distance Meter is described below: descriptions of the other two are given in the *Admiralty Navigation Manual* and in the maker's instructions supplied with the instruments.

STUART'S DISTANCE METER

This instrument measures the distance of an observer from an object of known height; it is useful for station-keeping in a fleet, or for anchoring or mooring on another ship.

It consists of a long curved lens attached to a radial distance scale graduated from a quarter of a cable to 30 cables. Both the curved lens and the distance scale are mounted in a slide, which can be moved up and down in a vertical direction by a ratchet worked by a pinion with a milled head.

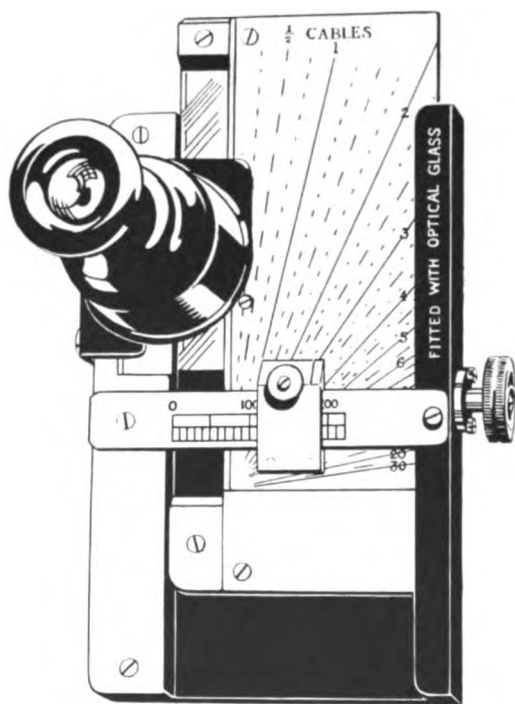


Fig. 341. Stuart's distance meter

Across the movable distance scale is a fixed horizontal metal bar, which is graduated from 0 to 220 feet. On this bar is a sliding pointer, the left hand edge of which should be set to the height of the observed object.

One edge of the curved lens moves alongside a fixed wedge-shaped lens, mounted in an aperture in the frame of the instrument. A small telescope fitted with an interrupted thread can be inserted in a metal collar, and when in place its field includes the centre of the fixed lens and a portion of the movable lens. The telescope should be focussed after being fitted in the instrument.

How to use it. Set the pointer to the height of the top of the object above the waterline, or to the height of the top of the object above the base of the

object, whichever is required. By turning the milled head of the pinion, move the slide up or down until the top of the object, as seen through the right or moving lens, is in line with the waterline or the base of the object, as seen through the left or fixed lens. The distance of the observer from the object is then indicated on the radial distance scale by the pointer.

On the reverse side of the instrument, opposite to the distance scale, is a skeleton table on white celluloid, on which the masthead heights of ships can be recorded in pencil.

When it is not possible to see the waterline directly beneath the object, when, for example, station is being kept on the foremast of a ship ahead, some point must be chosen to give the correct angle. This point is usually known by experience and may be, for example, the base of the after turret or the quarter-deck. It can be found by taking a rangefinder range of the mast, setting this range on the distance meter, and then looking through the telescope to observe where the top of the masthead cuts the hull of the ship.

CHAPTER XXII

Sounding

SOUNDING BY MACHINE

THERE are two methods of sounding by machine. The first consists of dropping a sinker or a long length of wire over the side and measuring, by mechanical means, the amount of wire run out when the lead touches the bottom. The result will have to be corrected for the speed of the ship and the height of the tide (if any) to obtain the true sounding. The corrections for the ship's speed are given in the table on page 626. With this method accurate soundings can be taken at speeds of up to 13 knots and in depths of up to 45 fathoms.

The second method employs the principle that the pressure of water increases with its depth. A glass tube, open at the bottom and sealed at the top, is placed in a metal guard case and secured to the sounding wire just above the sinker. As the tube descends, the water is forced up inside it to a height depending upon the depth of the water. When the tube is recovered the height to which the water has risen is measured against a specially graduated boxwood scale from which the corresponding depth of water can be read. To obtain the true sounding the result thus obtained must be corrected for the barometric pressure at the time and the height of the tide (if any). The corrections for barometric pressure are stamped on the back of the boxwood scale. With this method accurate soundings can be taken at speeds of up to 20 knots and in depths of up to 45 fathoms.

With either method soundings of any depth can be taken with the ship stopped.

Equipment (Figs. 342 to 344)

The equipment required to sound by machine consists of the "sounding boom" and the "sounding machine" with their associated parts, as described below. There are several types of sounding machine in use at sea, and the following is a description of the Kelvin sounding machine and equipment provided in the Royal Navy.

THE SINKER

This takes the place of the lead in the hand lead and line; it consists of an iron rod 3 feet long, the bottom of which is weighted with lead and hollowed out for arming, and the top of which is forged into an eye. The whole weighs 24 pounds. These sinkers are accurately made to ensure uniformity of length, shape and weight. They should be handled carefully as any distortion may produce an incorrect sounding.

THE WIRE

This takes the place of the lead-line, and consists of 300 fathoms of special seven-stranded wire; it is wound round the drum of the sounding machine, to which it is secured by reeving it through two small holes in the barrel of the

drum and back around its own part. The outboard end of the wire is fitted with a brass swivel-eye.

The wire should be kept well greased, and great care should be taken when winding it on the drum to prevent any kinks from forming, because one kink may necessitate scrapping the whole wire.

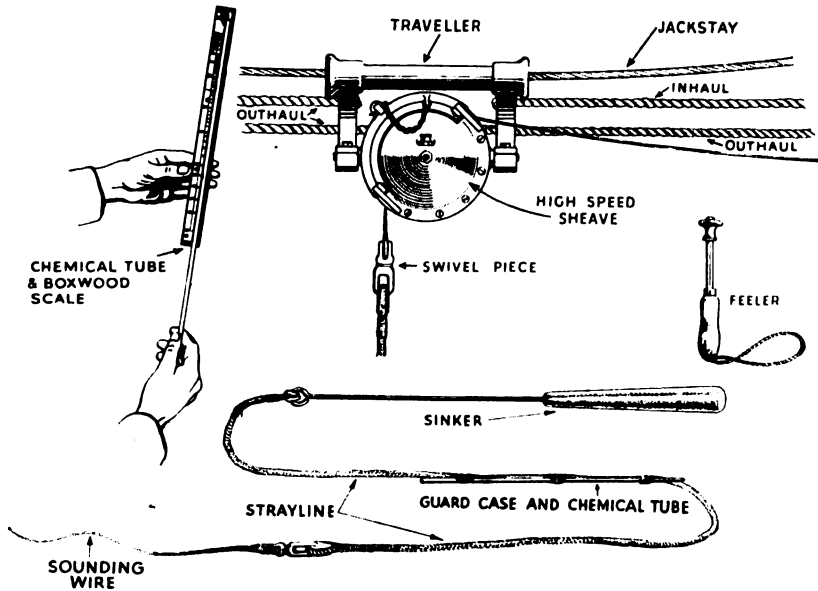


Fig. 342. Sounding machine equipment

When recovering the wire after taking a sounding it should be guided evenly along the drum by means of a canvas pad smeared with oil or Russian tallow.

THE STRAY-LINE

This is a 9-ft. length of log line which joins the wire to the sinker. One end is seized into the eye of the swivel piece, and the other into the eye at the head of the sinker. It is important that the length of the stray-line measured between the two eyes should be exactly 9 feet.

GLASS TUBES

These are about 2 feet in length and quarter-of-an-inch in diameter, and are supplied in boxes of ten tins, each tin containing ten tubes. The tubes, which are known as "chemical tubes", have their inside surfaces coated with a solution of chromate of mercury which gives them a red-brown colour. The action of the salt water turns the coating white, and when used in fresh water a pinch of dry salt must be put in the tube before sounding. Dampness adversely affects these tubes and they should therefore be stored in a dry place. Used tubes are "returnable" and should be stowed apart from unused ones.

When sounding, the tube is placed in a special brass guard-case, open end down, and the cap of the guard-case is replaced. The guard-case is then secured to the stray-line exactly 3 feet above the eye of the sinker.

SOUNDING BOOM

This is a wood or metal spar of sufficient length to guide the sounding wire outboard clear of the ship's side and propellers. Its heel is stepped in a convenient place to give the sounding wire a clear run outboard from the sounding machine. The boom is fitted with a jackstay, standing topping lift, and fore and aft guys, and is hinged for close-stowing when not in use.

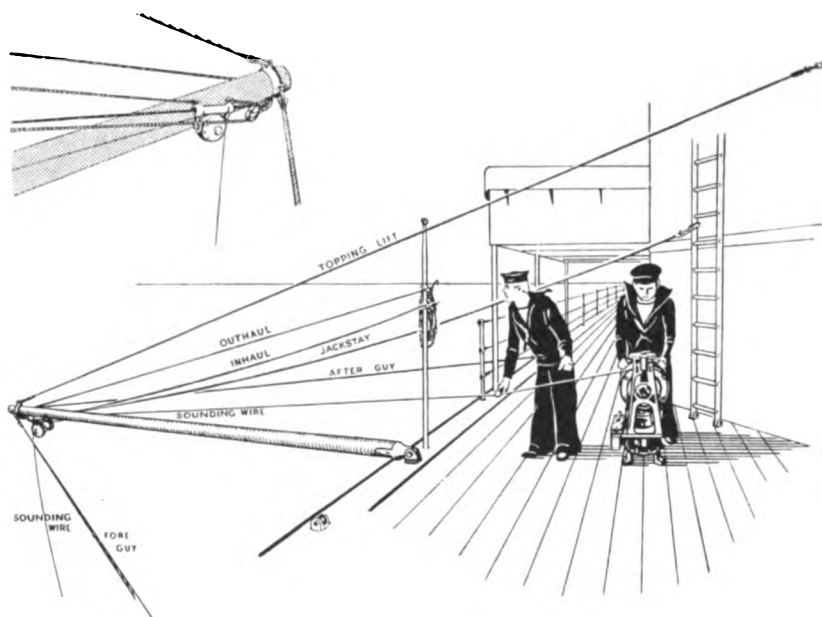


Fig. 343. Taking a sounding by machine
(Inset: Detail at the head of the boom)

A metal sleeve, called the "traveller", runs along the jackstay; it is fitted with an outhaul, which is rove through a small sheave at the end of the boom, and also with an inhaul.

The wire runs over a special high-speed sheave, running on oil-fed ball-bearings, which is fitted to the traveller on a trunnion bearing. The sheave bearings should always be kept well lubricated.

The sheave is enclosed in a casing which is hinged to allow the sounding wire to be snatched in, the casing being then moused with a pin.

THE FEELER

This is a metal tool with a grooved head, and a wooden handle fitted with a becket. The grooved head is pressed firmly over the wire as it runs out, and, by this means, the momentary slackening of the wire as the lead touches the bottom can be felt by the operator. Directly this slackening is perceived the amount of wire out should be read off the dial of the machine and its brake applied by a half turn of the hand wheel in an inboard direction.

SOUNDING MACHINE

This consists of a metal framework which is bolted to the deck and supports the wire drum, which revolves around a horizontal spindle. The drum can revolve freely, or be clutched into the drive of an electric motor for reeling in

the wire. The drum is fitted with a hand brake which, when applied, also connects the motor drive to the drum. The action of releasing the brake disconnects this drive. The drum is connected through a counter mechanism to a pointer which moves around the face of a dial situated on top of the machine. The dial is graduated in fathoms for a wire of 300 fathoms length. Allowance in the graduations is made for the progressively shorter length of wire which is reeled off for each turn of the drum. If a wire of less than 300 fathoms is used the pointer must be set to the number of fathoms missing before a sounding is taken, and this amount must be deducted from the figure shown after a sounding has been taken.

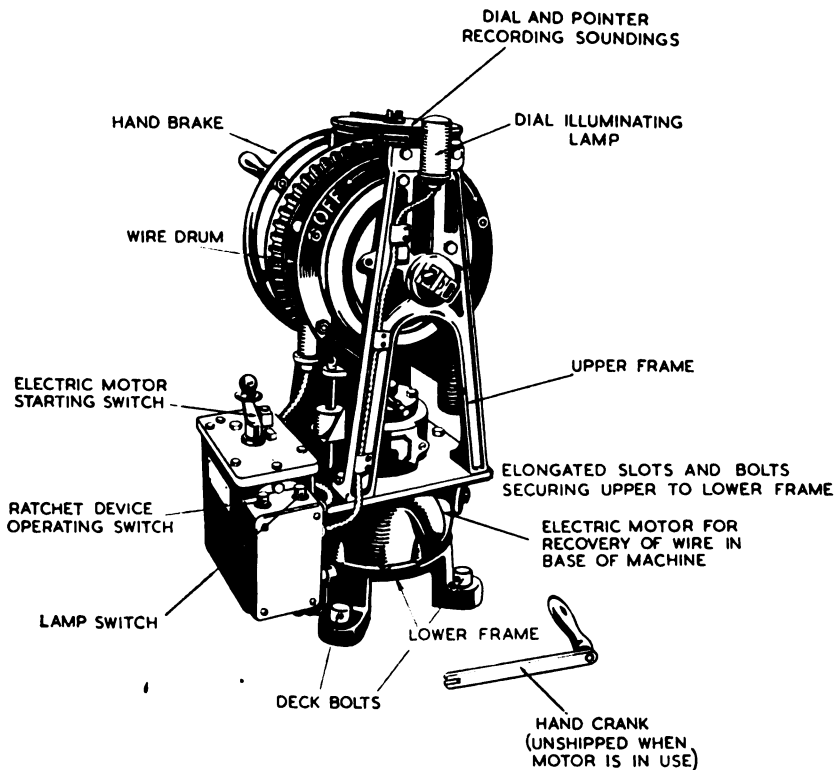


Fig. 344. A sounding machine

The hand brake is operated by a wheel mounted on the drum spindle. Half-a-turn of the wheel in an outboard direction frees the drum, and half-a-turn in an inboard direction brakes the drum. The drum is also fitted with an automatic brake which keeps the speed of the wire constant as it is veered and checks the drum when the lead touches the bottom, thus preventing the drum and wire from over-running. This automatic brake consists of two weights, suspended one on each end of a cord running over a pulley keyed to the shaft of the drum. Friction between the cord and pulley constitutes the braking action, and the weights can be altered to allow for different speeds of the ship. The special cord provided may be oiled to prevent rotting, and should be renewed from time to time.

An electrically operated ball and ratchet device is incorporated in the motor drive to enable the wire to be veered from the drum when the brake is in the "on" position. It is operated by a push-button switch and is used for adjusting the height of the lead above the surface of the water before taking a sounding.

The electric motor is used to recover the wire and sinker when a sounding has been taken. The control switch is operated by a handle which allows the wire to be recovered at slow, half, or full speed. The motor is connected to the drum through bevel wheels, which are clutched in and out of drive by the action of the brake.

Should the motor break down temporarily the wire can be recovered by hand by shipping a handle to the rim of the brake wheel and then turning the drum with it. Should the breakdown be likely to be of long duration, the machine should be disconnected from the motor drive by slacking back the nuts holding the upper framework of the machine to the motor casing, and then moving the upper part of the machine to the limit of the slotted holes. This action disengages the bevel wheels of the motor drive, and the hand crank can then be shipped on the end of the drum axis opposite to the brake wheel, and the wire be recovered by hand. When reverting to motor drive, great care should be taken to ensure that the bevel wheels are correctly aligned. Before working a sounding machine always ensure that the framework is properly secured and correctly aligned.

How to Take Soundings

To take soundings the sounding party, consisting of a leading seaman and two men, should proceed as follows :—

- (i) Rig the sounding boom outboard and set up the guys.
- (ii) If sounding by tube place a tube in the guard-case, open end down, and replace the guard-case cap. The guard-case is secured to the strayline 3 feet above the eye of the sinker. Keep the tubes sheltered from spray or rain.
- (iii) If sounding without tubes, set the pointer on the dial to zero when the sinker is in the position for letting go. If using less than 300 fathoms of wire, set the pointer at the amount by which the wire is short of 300 fathoms.
- (iv) Put the hand brake on by moving it half-a-turn inboard.
- (v) Snatch the sounding wire into the traveller sheave and mouse the casing. Lower the sinker and tube over the side and haul the traveller out to the end of the boom. As the traveller moves out, overhaul sufficient wire from the drum and at the same time operate the ratchet-device button-switch. When the traveller is out to its full distance, belay the outhaul. Lower the sinker to a position just clear of the waves, overhauling the wire as necessary with the aid of the ratchet-switch.
- (vi) Place the head of the feeler on the sounding wire, exerting a firm pressure ; the deeper the water the firmer will be the pressure required. To let go the sinker take off the brake by turning the brake wheel half-a-turn in an outboard direction. The brake should be operated evenly and never jerkily.

- (vii) Immediately the feeler indicates to your hand that the wire is slackening, the brake should be put on by giving half-a-turn of the wheel in an inboard direction, and, at the same time, the reading of the pointer on the dial should be noted.
- (viii) Reel in the wire by starting the motor slowly, and then increase to half speed and then full speed. As the wire is hove in guide it on to the drum so that it is evenly spaced, using a canvas pad smeared with oil or Russian tallow.
- (ix) When all but 10 fathoms of wire are recovered ease down, stop the motor, and then recover the remaining length by turning the hand-brake wheel in an inboard direction. When the swivel-piece is close up to the sheave, check the outhaul and haul in the inhaul so that the traveller will move in to the heel of the boom. Then recover the sinker and tube over the guardrails, taking care to keep the tube upright.
- (x) When sounding by tube remove it from its guard-case, and, still taking care to keep it upright, place it in the boxwood scale and note the reading. Correct this reading for barometric pressure from the corrections given on the back of the scale, subtract the height of the tide (if any) and report the corrected sounding to the Bridge and note it in the *Sounding Book*.
- (xi) When sounding without a tube correct the reading of the dial-pointer for the speed of the ship (found in the *Speed and Depth Tables* (see page 626) provided by the Navigating Officer. This reading may have to be further corrected when using a wire of less than 300 fathoms, by subtracting the amount the wire is short of 300 fathoms. Subtract the height of the tide (if any), report the corrected reading to the Bridge, and note it in the *Sounding Book*.
- (xii) If no more soundings are to be taken replace gear and put the hand brake to the "off" position.

The brake should never be left on when the sounding machine is not in use, as this may cause jamming of the mechanism.

Causes of Incorrect Soundings by Chemical Tube. Incorrect soundings may be caused by :—

- (i) an incorrect length of stray-line, and consequent incorrect position of guard tube ;
- (ii) allowing the wire to over-run, thus allowing the tube and some of the wire to lie horizontally on the sea bed ;
- (iii) applying the brake too suddenly, thus jerking the water up and down in the tube ;
- (iv) not keeping the tube vertical during recovery, or when removing it from the guard-case.
- (v) condensation in the tube, which, if there is a large difference between sea and air temperatures, can be prevented by immersing the tube before sounding in a bucket of sea water, sealed end down and open end at least one inch above the surface ;
- (vi) a very soft bottom, causing the lead to oscillate.

SPEED AND DEPTH TABLE

MACHINE, Kelvin's Mark 4 or Motor.
 SINKER, Kelvin's M.C. I with lead core,
 weight 24 pounds.
 STRAY-LINE, 12 feet long.
 WIRE, seven-strand.

AUTOMATIC BRAKE WEIGHT, 6 pounds.
 WIRE LED THROUGH Kelvin's carrier
 and block.
 GUARD TUBE, seized on 3 feet above
 eye of sinker.

Approx. Vertical Depth	FATHOMS OF WIRE RUN OUT								Approx. Vertical Depth	FATHOMS OF WIRE RUN OUT							
	<i>Speed in Knots</i>									<i>Speed in Knots</i>							
	6	7	8	9	10	11	12	13		6	7	8	9	10	11	12	13
<i>Fms.</i>									<i>Fms.</i>								
5	6½	7	7½	8½	9½	10	10½	14	26	33½	36½	39½	43	46½	49½	53	56½
6	7½	8	9	10	11½	12½	13	16	27	35	38	41	44½	48½	52	55½	58½
7	9	10	10½	12	13½	14½	15	18	28	36	39	42½	46	50	53½	57½	61
8	10½	11½	12	13½	15	16	17	20	29	37	40	43½	47½	52	56	60	63
9	11½	12½	14	15½	16½	18	19	22	30	38½	41½	45	49	53½	57½	62	65
10	13	14	15½	17	18½	20	21½	24	31	40	43	46½	51	55½	60	64½	
11	14½	15½	16½	18	20	21½	23	26	32	41	44½	48	52½	57	62	67	
12	15½	16½	18	19½	21½	23	25	28	33	42½	46	49½	54	59	64	69	
13	17	18	19½	21	23	25	27	30	34	43½	47	51	55½	60½	66	71½	
14	18	19½	21½	23	25	26½	28½	32	35	45	48½	52½	57½	62½	68	74	
15	19½	21	23	24½	26½	28½	30½	34	36	46	50	54					
16	20½	22½	24½	26	28	30	32½	36	37	47½	51½	55½					
17	22	24	26	28	30	32	34½	38	38	48½	52½	57					
18	23	25	27½	29½	31½	34	36½	40	39	50	54	58½					
19	24½	26½	29	31	33½	36	38½	42	40	51	55½	60					
20	26	28	30½	32½	35	37½	40½	44	41	52½							
21	27½	29½	32	34½	37	39½	42½	46	42	54							
22	28½	31	33½	36	39	42	45	48	43	55							
23	30	32½	35	38	41	43½	46½	50	44	56½							
24	31	33½	36½	39½	42½	45½	49	52	45	58							
25	32½	35	38	41½	45	48	51	54½									

These tables should not be implicitly relied upon until sufficient experience has been gained to enable an opinion to be formed about their trustworthiness when they are used with different machines. See remarks concerning sounding without tubes.

Correction by Speed and Depth Table, when Sounding without a Tube. The vertical depth is found by entering the Speed and Depth Table opposite with the speed of the ship and the amount of wire run out. As a rule this table will not apply to individual ships unless some small corrections are made to meet their peculiarities, and a series of graphs for different speeds should be constructed as described below and illustrated in Fig. 345.

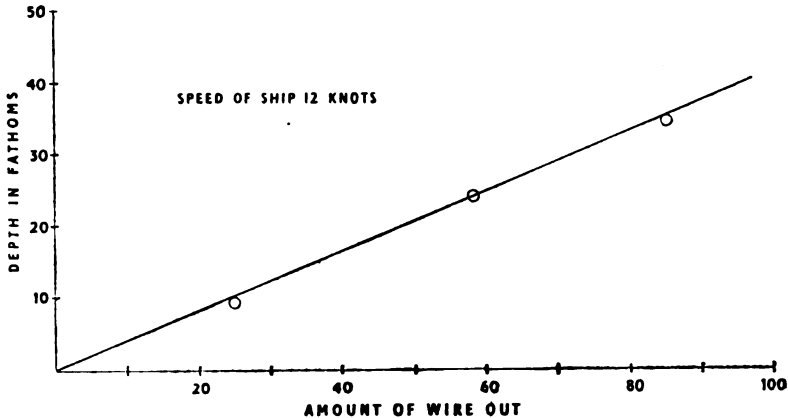


Fig. 345. Specimen graph for a speed of 12 knots

Take three soundings by tube, if possible with large variations in depth between them, and on each occasion observe the amount of wire run out. Correct the soundings and plot them against the amount of wire run out, as shown in Fig. 345. The graph should be a straight line passing through the origin. Compare the results given by the graph with figures in the table for that particular speed, and correct the table as necessary.

ECHO SOUNDING

Echo sounding is the principal means of obtaining soundings in ships having the necessary equipment, and it is used instead of the hand lead and the sounding machine on most occasions.

Principle of Echo Sounding (Fig. 346)

Sound travels at a known speed through air and water, and when it strikes an obstruction it is reflected back along its outward path at the same speed in the form of an echo. If the interval of time between the emission of a sound and the return of its echo is measured, the distance between the point of origin of the sound and the obstruction causing the echo can be calculated.

This principle has been used for many years by ships in fog to determine their distance from nearby dangers such as cliffs or icebergs. A gun would be fired and the interval taken between the time of firing and the arrival of the echo. A rough rule for converting the time interval into distance is that the duration of the interval in seconds less one tenth equals the distance of the object in cables (one cable being 200 yards).

This principle, when used in determining the depth of water underneath a ship, is known as "echo sounding".

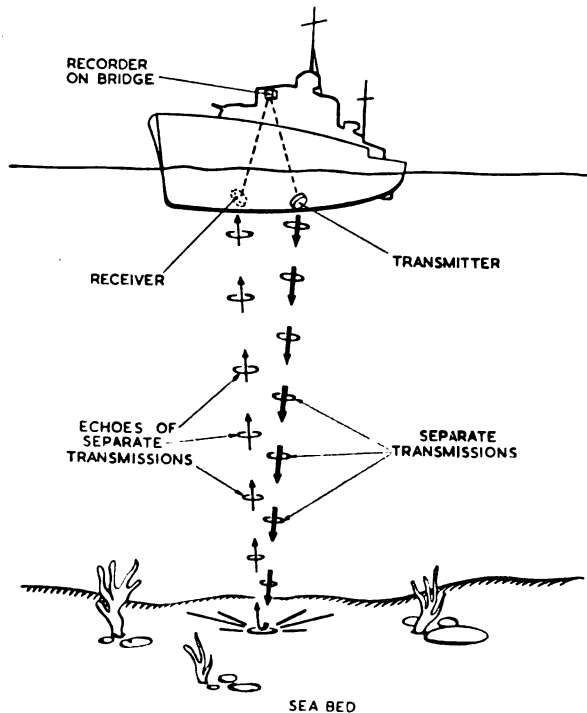


Fig. 346. Diagrammatic representation of echo sounding

Equipment

Because of the high speed of sound (4,820 feet a second in water) and the comparatively short distance it travels between the ship and the bottom, it would be impracticable to measure the required interval of time by human agency. Mechanical and electrical equipment is therefore provided for transmitting the sound, receiving its echo, and recording the interval and transforming it into a measurement of depth.

This equipment consists of a transmitter and a receiver situated in the bottom of the hull, both of which are electrically connected to an instrument called "the recorder", which is situated in the bridge-structure, in or near the charthouse.

When the recorder is switched on, the transmitter sends out a series of supersonic impulses and the resultant echoes are picked up by the receiver and relayed to the recorder. The recorder transforms the intervals between the supersonic impulses and their echoes into soundings, and at the same time records the results on paper.

"Supersonic" is a term describing impulses whose vibrations are above the range of audible sound. This type of impulse is used with modern echo sounding gear to prevent the presence of the ship being disclosed to submarine hydrophones when the set is in use, and because it will not detonate acoustic mines or other explosive instruments which are operated by sound.

The supersonic operation of the system necessitates the inclusion of another instrument called the "flashing unit", the purpose of which is to re-energise the mechanism of the receiver in an electro-magnetic sense. This may have to be done after the set has been in continuous operation for some time, or if it has been out of use for some time.

Echo-Sounder, Type 765

This type is now fitted in the majority of H.M. ships and is a supersonic set with a frequency of about 14 kc/s. It would not be practicable within the scope of this chapter to give a description of the complete equipment, but, as a working knowledge of the recording unit is necessary in order to operate it, the following description is included.

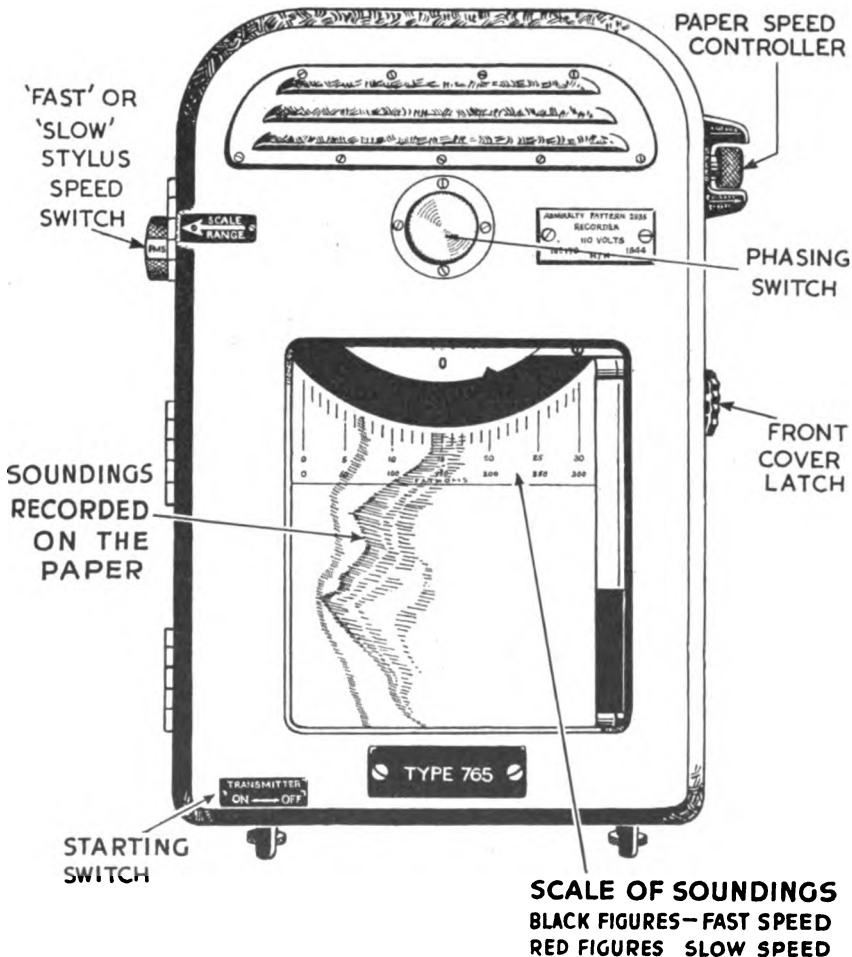


Fig. 347. Type 765 echo sounder recording unit

In the recorder box is placed a roll of chemically treated damp paper which is made to pass slowly over the surface of a metal plate by means of an electrically controlled roller mechanism. The soundings are recorded on this

sheet of paper by means of a "stylus", which makes contact with the paper and leaves a brown mark on it every time an echo is received. The intensity of this mark can be controlled by a "sensitivity control" situated on the amplifier. The speed at which the paper moves can be controlled; the faster the speed the further apart will be the recorded soundings, and vice versa.

The stylus is a metal pen which revolves around an axis situated near the top of the recorder box behind the phasing switch, and on the lower half of its travel it passes over the face of the paper. The movement of the stylus is synchronised with the transmission of the impulses, and the distance it travels between the transmission of an impulse and the reception of the resultant echo will give the sounding if measured against a suitable scale.

FAST AND SLOW SPEED SETTINGS, AND "PHASING"

The deeper the sounding the longer will be the interval of time between impulse and echo, and the farther the stylus will travel before recording the sounding. It will therefore be seen that an impracticably large recording unit would be required to cover a wide range of soundings, but this difficulty is overcome by arranging two different speeds for the stylus: a fast speed for shallow soundings, and a slow speed for deep soundings. In the unit under consideration the fast speed is scaled for soundings of from 0 to 30 fathoms, and the slow speed (which is one tenth of the fast speed) covers a range of from 0 to 300 fathoms. The minimum recordable depth is about from 6 to 9 feet below the bottom of the ship. These speeds are controlled by the "scale range switch" situated on the left-hand side of the recorder.

Two scales are provided: one marked in black figures for the fast speed, and one marked in red figures for the slow speed.

A further range of soundings for each speed setting can be obtained by means of "phasing", which in effect puts back the starting point of the stylus—in steps of 20 fathoms up to 80 fathoms for the fast speed, and in steps of 200 fathoms up to 800 fathoms for the slow speed. By means of phasing, a range of soundings of from 0 to 110 fathoms ($30 + 80$) can therefore be obtained at fast speed, and from 0 to 1,100 fathoms ($300 + 800$) at the slow speed.

Soundings can be recorded with greater accuracy at the fast speed than at the slow speed; when the probable range of soundings required is covered by either speed setting it is therefore preferable to phase at the fast speed.

When phasing it must be remembered that the amount of phase has to be added to the sounding indicated by the scale.

Phasing is controlled by the switch at the top of the cover of the recorder, and this switch should only be turned clockwise.

Two instances should suffice to illustrate the use of fast and slow speeds, and of phasing:—

- (i) The depth of water is known to be about 60 fathoms.
Use fast speed setting and set phase to 40 fathoms. Read the recorded sounding off the black scale and add 40 fathoms to obtain the correct sounding.
- (ii) The ship is passing from 500 fathoms to comparatively shallow water. First use the slow speed setting and set the phase to 400 fathoms. Read the recorded sounding off the red scale and add 400 fathoms to obtain the correct sounding. As the water shoals, phase down in successive steps at the slow speed until the soundings are less than 110

fathoms. Now switch to fast speed and phase to 80 fathoms, and thereafter phase down as necessary as the water shoals still further.

The "flashing unit" provides a means whereby the receiver can be re-energised in an electro-magnetic sense. Because of the peculiarities in the construction of the receiver, it loses its magnetic energy if used for long periods or when it has been allowed to lie idle for a long while. This lack of energy is shown by faint recording, or even by a complete absence of records. In these circumstances the flashing unit should be operated in accordance with the instructions shown on the cover of the unit. It should also be operated once a month if the set has not been in use.

OPERATING PROCEDURE

To operate the set, the following routine should be carried out—

- (i) Make the A.C. and D.C. main switches. This starts the recording unit and supplies power to the motor and amplifier.
- (ii) Put the "starting switch" at the bottom of the recorder to ON. This starts the remainder of the system.
- (iii) See that the paper is damp. If the set has not been in use for a day or two it may be necessary to pull off a certain amount of dry paper.
- (iv) Set the paper to the speed required.
- (v) Set the speed of the stylus to the required setting.
- (vi) Adjust the phasing switch to the required setting.
- (vii) Adjust the sensitivity to AUTO or MANUAL, in accordance with the instructions on the face of the amplifier. The intensity of the sounding marks can be increased by the small rotary switch provided. If, after these adjustments, the recordings are faint or invisible, operate the flashing unit in accordance with the instructions on its cover.

CHAPTER XXIII

Latitude and Longitude, Charts and Hydrographic Publications

LATITUDE AND LONGITUDE

THE Earth may be represented, on a small scale, as a globe with the oceans and continents mapped on its surface (Fig. 348). In order to describe the exact position of any place on this globe it is covered with a network of lines from which the location of a place can be described with reference to the network.



Fig. 348. A globe

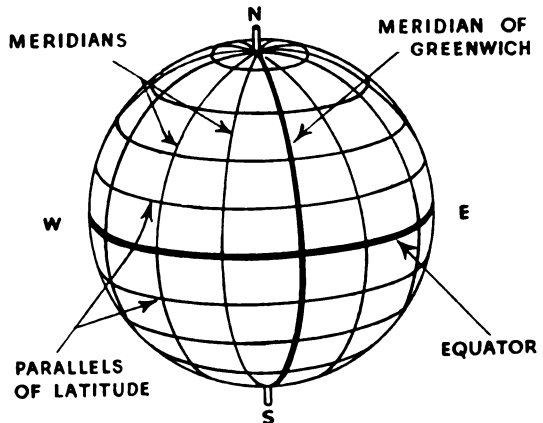


Fig. 349. Parallels of latitude and meridians

Parallels of Latitude, and Meridians

The lines of this network which encircle the globe and are parallel with the equator are called "parallels of latitude". Notice that they diminish in circumference the nearer they approach the poles.

The lines which run from pole to pole over the surface of the globe are called "meridians", the one passing through Greenwich being called the "meridian of Greenwich" (see Fig. 349).

A meridian runs due north and south, and a parallel of latitude runs due east and west; a meridian and a parallel of latitude therefore intersect each other at a right angle.

Latitude

The latitude of a place is the angular measurement between its parallel of latitude and the equator. The angle is measured at the centre of the globe in the plane of the meridian of the place, and is expressed in degrees, minutes, and seconds, from 0° to 90° north or south of the equator.

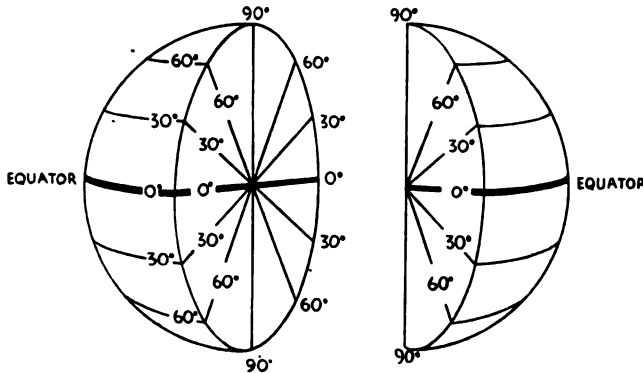


Fig. 350. Angular measurement of latitude

Longitude

The longitude of a place is the angular measurement between its meridian and the meridian of Greenwich. The angle is measured at the centre of the globe in the plane of the equator, and is expressed in degrees, minutes, and seconds, from 0° to 180° , east or west of the Greenwich meridian.

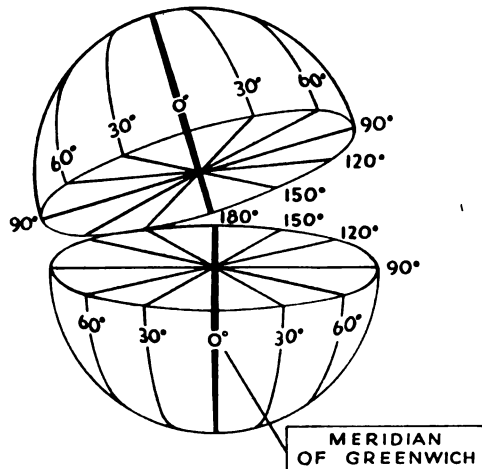


Fig. 351. Angular measurement of longitude

Position

The position of a place can therefore be described in terms of longitude east or west of the Greenwich meridian, and in terms of latitude north or south of the equator. The Cork Light Vessel off Harwich, for example, is in latitude 51 degrees, 56 minutes, 10 seconds north of the equator, and in longitude 1 degree, 23 minutes, 48 seconds east of Greenwich. This position is recorded thus :—

51° 56' 10" N.
01° 23' 48" E.

Linear Measurement of Latitude

The distance represented on the surface of the Earth by a degree of latitude is approximately the same no matter at what position on the Earth it is measured. For instance, the actual distance between 30 degrees and 60 degrees south will be the same as that between 0 degrees and 30 degrees north. One minute of latitude is therefore taken as the standard unit of measurement at sea, and is called the nautical or sea mile.

Because the Earth is not exactly spherical in shape, the nautical mile is calculated from a minute of latitude at 48 degrees north of the equator, where it measures exactly 6,080 feet.

One degree of latitude will measure 60 nautical miles, or 69 statute miles.

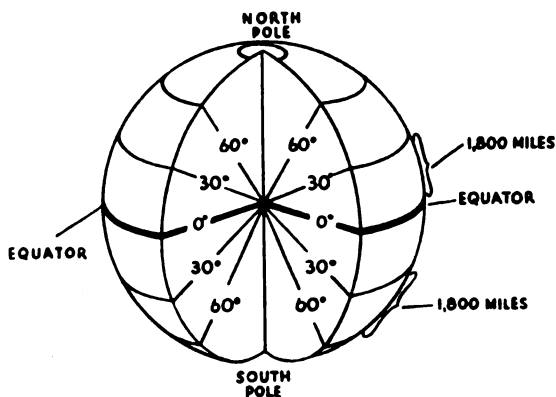


Fig. 352. Linear measurement of latitude

Linear Measurement of Longitude

It will be seen that the distance on the Earth's surface between any two meridians is greatest at the equator and diminishes uniformly until it is nothing at the poles, where all the meridians meet. The linear distance of a degree of longitude on the surface of the Earth therefore varies in accordance with its latitude, and cannot be taken as a standard measure of length. For instance, the distance on the Earth's surface representing 30 degrees of longitude at latitude 60° N is 902½ sea miles, whereas 30 degrees of longitude at the equator is represented by 1,800 sea miles.

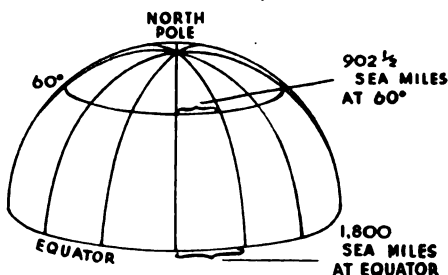


Fig. 353. Linear measurement of longitude

The Great Circle (Fig. 354)

A great circle is any circle whose plane passes through the centre of the Earth, and it is the largest circle one can describe on the Earth's surface. The arc of a great circle is the nearest approach to a straight line which can be drawn on the Earth's surface, and must therefore be the shortest distance between two points. Each meridian is half a great circle, because it joins the poles and its plane passes through the centre of the Earth.

The Rhumb Line (Fig. 355)

Any line which crosses the meridians or the parallels of latitude at the same angle is called a "rhumb line". A rhumb line is not the shortest distance between any two points.

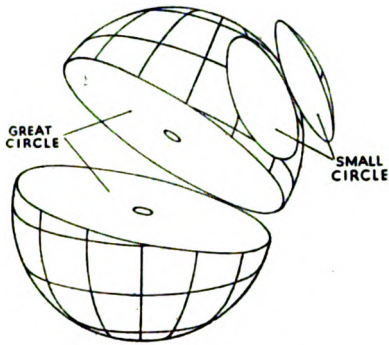


Fig. 354. A great circle

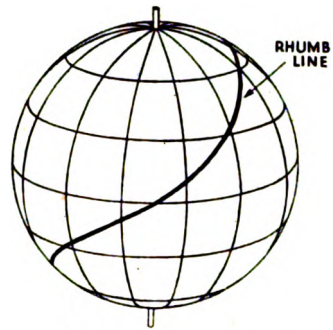


Fig. 355 A rhumb line

MAPPING

It would be impossible to navigate accurately with the sole aid of a globe, because the drawing of courses and measurement of bearings on a curved surface is difficult and the size of the globe would have to be so large as to render the

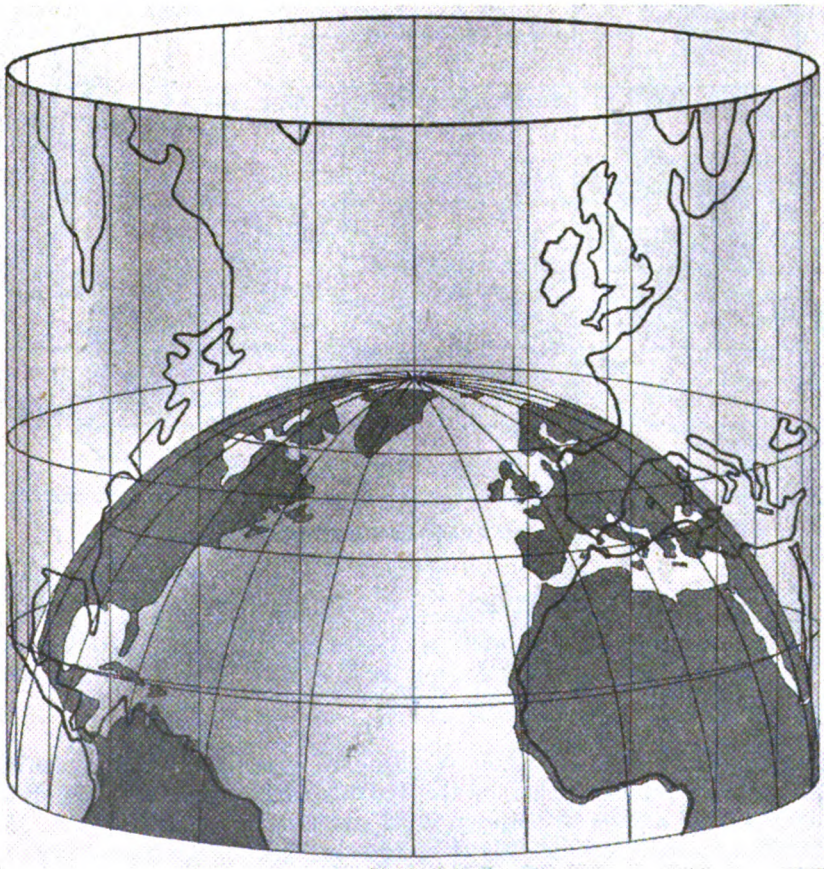


Fig. 356. Principle of the central-cylindrical projection

procedure impracticable. Some means must therefore be found whereby the configuration of continents and oceans can be represented on a flat surface. There are many practical methods of doing this, but each involves a distortion in one way or another of the proportions of the Earth's surface.

Mercator's Projection

The method most generally used at sea is the "Mercator's projection", which is a modified form of the "central cylindrical projection", the principles of which are shown in Fig. 356.

Imagine a transparent globe surrounded by a cylinder of paper and with a bright light shining at its centre. The light will throw the shadows of the land, with its continents, islands, etc., on to the inner surface of the cylinder, on which their configuration can be drawn. When the cylinder of paper is unrolled the result will be a representation of the Earth on a flat surface, as shown in Fig. 357.

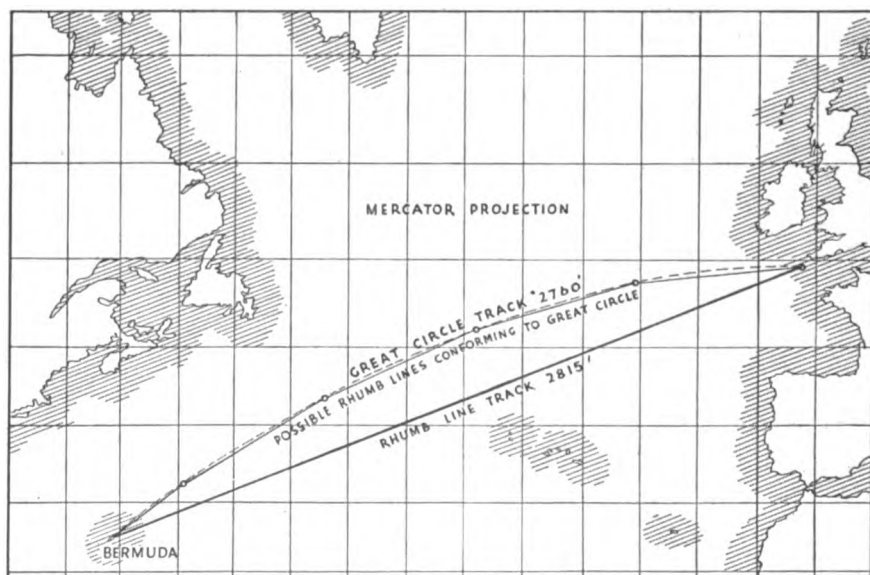


Fig. 357. Mercator's projection of the North Atlantic

Degrees of longitude are marked along the top and bottom of the map eastward and westward of the meridian of Greenwich, from 0 to 180 degrees.

Degrees of latitude are marked along the side of the map north and south of the equator, from 0 to 90 degrees.

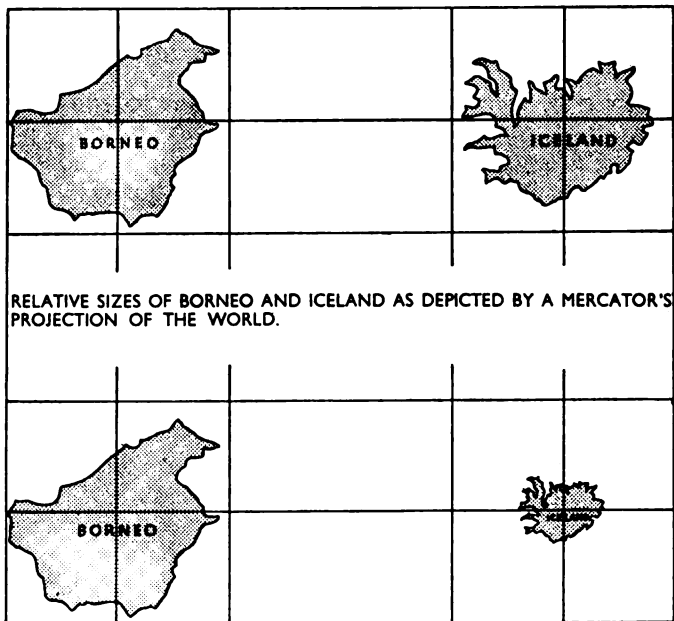
Distortions caused by Mercator's method. The distortions and peculiarities of this form of representation of the Earth's surface are explained below and they should always be borne in mind when using a chart (see Fig. 357).

The distance between parallels of latitude increases progressively from the equator towards the poles. This results in a progressive lengthening of all features the farther they are from the equator.

Parallels of latitude, whatever the relative lengths of their circumferences on the Earth's surface, all appear the same length on the chart.

The meridians, instead of meeting at the poles, are represented as straight lines lying parallel with each other and at a constant distance apart. This results in a progressive broadening of all features the farther they are from the equator.

As an example of this distortion, Iceland, lying approximately in latitude 65 degrees north, appears to be about the same size as Borneo, lying on the equator. But Iceland is only 270 miles long and 190 miles broad, whereas Borneo is 620 miles long and 600 miles broad. Fig. 358 shows the comparative sizes of the two islands as shown on a Mercator's chart and when drawn to the same scale.



ACTUAL RELATIVE SIZES OF BORNEO AND ICELAND.

Fig. 358

Three important points therefore arise :—

- (i) Distance must be measured at its approximate latitude. The distance between the Isle of Wight and Jersey, for example, must be measured from the latitude scale at the side of the chart opposite the Channel ; if this distance was measured off the latitude scale opposite, say, the south coast of France, the result would be entirely erroneous. (Remember that the minute of latitude represents one sea mile.)
- (ii) Any straight line drawn on a Mercator's chart must cut the meridians at the same angle, and is therefore a rhumb line. A ship steering a steady course traverses a rhumb line track (see Fig. 357). (Remember that the rhumb line is not the shortest distance between any two points.)

- (iii) A great circle, which is the shortest distance between any two points, will appear as a curved line, and will therefore give the false impression that it is longer than the rhumb line joining the same two points (see Fig. 357).

The difference between the plotting of a great circle and a rhumb line on charts can be disregarded in the case of the large scale charts used for pilotage purposes; but in ocean navigation, the difference in distance between two places such as Land's End and Bermuda can be quite considerable.

Gnomonic Projection

The distortion at high latitudes of Mercator's method of projection is so great that this method is seldom used to chart the surface of the Earth in latitudes of over 80 degrees north or south. The areas around the poles are usually charted by a method known as the "gnomonic projection", the principle of which is described below and illustrated in Fig. 359.

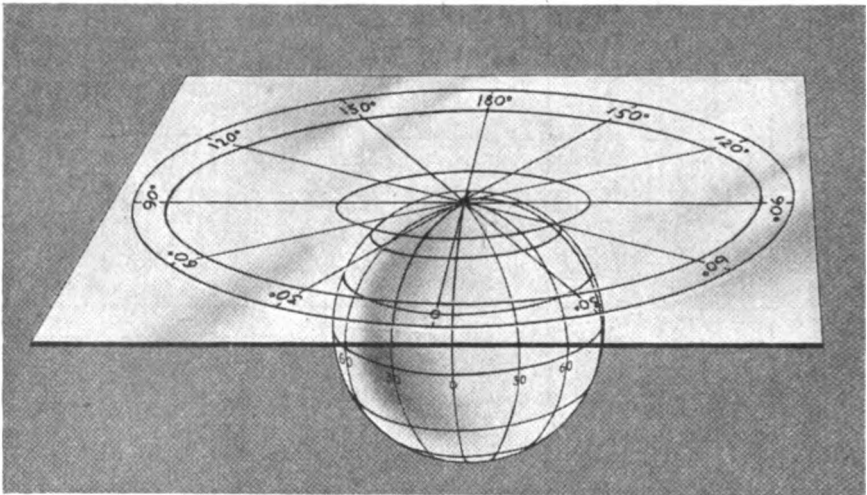


Fig. 359. Principle of the gnomonic projection

A sheet of paper is placed with its centre touching either the North or South Pole of the globe, and with its plane parallel to the plane of the equator. A light shining at the centre of the globe will project the shadows of the land on to the under-side of the paper, where they can be drawn in.

With the gnomonic projection taken at the poles the parallels of latitude will appear as concentric circles, and the meridians will radiate in straight lines from the pole at their correct relative angles. Great circles will appear as straight lines and rhumb lines as curved lines.

Degrees of longitude, from 0 to 180, are marked around the perimeter of the chart each side of the meridian of Greenwich, and degrees of latitude are marked on the concentric circles from the pole outwards, starting at 80 nearest the pole and diminishing as they approach the equator.

Gnomonic projections can be taken at any position on the Earth's surface; those taken at the poles are called "polar charts", and when taken elsewhere they are called "great circle charts".

Great circle charts are useful in determining the shortest track to follow over a long distance between any two places on the Earth. These tracks are transferred to a Mercator's chart for navigational purposes.

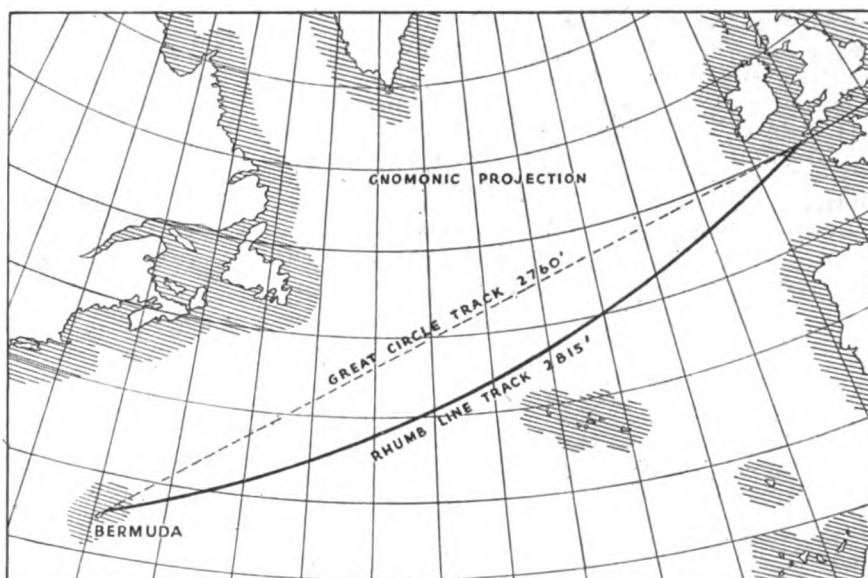


Fig. 360. A great circle chart of the North Atlantic

Fig. 360 is a reproduction of a great circle chart, and on it are shown the great circle and rhumb line tracks between Lands End and Bermuda. In order to follow a great circle track accurately a ship would have to alter course continuously to follow the curved line; in practice, however, the ship follows a track consisting of a series of rhumb line courses which approximately follow the great circle track. This track will have to be altered as necessary to avoid land and navigational dangers such as ice and shoals.

ADMIRALTY CHARTS AND HYDROGRAPHIC PUBLICATIONS

The Hydrographic Department of the Admiralty, at the head of which is the Hydrographer of the Navy, is a large organisation responsible for the whole production, printing and issue of Admiralty charts and books for H.M. ships and the Merchant Navy throughout the world, and for fishing vessels in home waters. The Hydrographer is also the head of the Surveying Branch, which is continuously employed, mainly in British waters, in making new surveys or revising old ones. The publication of their work, and of that received through an exchange of information with foreign governments, ensures that all the navigable waters of the Earth are charted. Thus from the moment the first mark is erected on the site of a new survey in some far distant land until the copy of the resultant chart lies on your chart table, the Hydrographic Department is chiefly concerned. Nor does its work stop there, because as new features are discovered, new dangers disclosed, or new demands made for further details, the department keeps all mariners in every part of the world informed of them by means of weekly "*Admiralty Notices to Mariners*".

Charts : types, publication, issue, indexing and grouping**TYPES OF CHART**

Charts are issued to cover large or small areas of the seas and coastal regions of the land. A chart which represents a small area is called a "large-scale chart", and one which covers a large area is called a "small-scale chart". The terms large-scale and small-scale refer to the ratio between the size of details shown on the chart and their actual size. If, for example, the scale of a chart is shown as $1/12,500$, it means that the details on the chart have been reduced 12,500 times; whereas on a small-scale chart on which the scale is shown as $1/1,000,000$ the details have been reduced 1,000,000 times.

For ocean navigation small-scale charts are used, but when approaching land large-scale charts are used, and finally, when entering port, the largest scale charts called "plans" are used.

In all navigation the largest scale chart available should be used for two reasons: firstly, the larger scale charts are always corrected first and contain the most details; and secondly, if the paper of the chart has been distorted during printing, or by climate and weather, any resultant errors will have less effect on the accuracy of navigation.

PUBLICATION OF CHARTS

It is most important that charts used for navigational purposes should contain the most detailed and up-to-date information available; they are therefore under constant revision in the Hydrographic Department, which, from time to time and as the necessity arises, issues new charts and new editions of old charts, and reprints of existing editions. All such issues are published in *Admiralty Notices to Mariners* to enable users of charts to obtain the most up-to-date charts available.

The age and state of a chart are also indicated along its bottom margin, and by comparing the information there recorded with the latest *Catalogue of Admiralty Charts* and other Hydrographic publications the mariner can ascertain whether it is the most up-to-date chart available. (The catalogues are published yearly at the beginning of April and are corrected to the 1st January of that year.)

Information regarding the age and state of a chart is recorded on it as follows :—

- (i) The date of publication of a new chart is shown in the middle of the outer bottom margin of the chart, e.g. "Published at the Admiralty, 1st June, 1936".
- (ii) When a chart is revised throughout or modernised in style, a new edition is published, this fact being recorded to the right of the date of publication, e.g. "New edition, 3rd December, 1940".
- (iii) When the necessity arises for large corrections to be made to a chart which are too comprehensive for publication in *Admiralty Notices to Mariners*, a reprint is issued embodying such large corrections. This is recorded below the date of edition, e.g. "Large Corrections, 15th July, 1942".
- (iv) When a reprint is issued, certain minor corrections of insufficient importance to warrant their notification by an *Admiralty Notice to*

Mariners are embodied in it. These are recorded in the bottom left-hand corner in one of two ways: 1943 [7.18] or 1943 (vii. 18), for example, both of which indicate that the chart received minor corrections on the 18th July, 1943.

- (v) Small corrections to charts which are published in *Admiralty Notices to Mariners* are subsequently made by hand, either at the chart depot, or at the chart agency, or by the actual user of the chart. Such small corrections are recorded in the bottom left-hand corner of the chart by inserting the number of the relevant *Notice to Mariners* against the year of issue, e.g. "Small Corrections, 1943—17—224—909, 1944—86—107", etc. They are also embodied and recorded in any subsequent reprints.

Whenever a new chart, a new edition, or a reprint is published, a notice to this effect is published in *Admiralty Notices to Mariners* and the old copies are cancelled and withdrawn from chart depots, chart agencies, and H.M. ships, on receipt of the new copies.

ISSUE OF CHARTS

General Information relating to the supply of Admiralty charts, navigational publications, maps, chronometers and watches, and the correction of charts and navigational publications, is given in the *Hydrographic Supplies Handbook (H.51)*. Information regarding Fleet navigational charts and other Admiralty charts and publications in the various security categories is given in *Hydrographic Pamphlet H.D.303*. The handbook *H.51* is supplied to all ships issued with an Admiralty chart outfit, and the pamphlet *H.D. 303* is supplied to all ships issued with Fleet chart folios. In the Royal Navy charts are supplied by the Hydrographer to Admiralty Chart Depots situated at the chief Royal Dockyards at home and abroad, from which they are issued to H.M. ships. The general public can purchase Admiralty charts and other hydrographic publications from Admiralty chart agents situated at the principal ports of the world. A list of these agents is published annually in *Admiralty Notice to Mariners No. 2*. All charts issued by the Hydrographic Supplies Establishment at Taunton, or by chart depots, are corrected to the latest available *Notice to Mariners*, but they are not corrected for any temporary and preliminary notices. Chart agents are expected to maintain their stocks up-to-date.

On first supply of a chart outfit a set of weekly editions of *Admiralty Notices to Mariners*, the latest monthly list of T. & P. (Temporary and Preliminary) notices in force, and any T. & P. notices published since the latest weekly edition, are issued with the outfit. It is the first duty of the Navigating Officer to correct the charts, in pencil, from information given in the T. & P. notices.

INDEXING AND GROUPING OF CHARTS

For convenience of identification each chart is given a reference number, of which numbers there are now (1951) about 4,000. This number is printed at the bottom right and top left corners of the chart, and also on the "thumb label" which is pasted or printed on the back of the chart. The thumb label provides spaces for notation of the serial and consecutive numbers of the chart folio.

Navigational charts which cover a certain area (e.g. the English Channel) are grouped together in what is called a chart folio, and the folio is given a number (in this case Folio 1). To cover the globe there are 87 complete chart

folios (1-100 series), and the areas covered by each are shown on a special chart No. X.6051, *Limits of Admiralty Chart Folia*, which is included at the back of H.51.

When a ship is to make a passage from one part of the world to another she does not always need every chart published for each area through which she will pass. Remember that possession of a chart entails the task of constantly correcting it to keep it up to date, and with many hundreds on board this can be very irksome. Such a ship is often supplied with complete chart folios only for the area in which she will eventually operate, and her passage to that place is covered by the supply of "Abridged Chart Folia", in the 100 series.

Abridged chart folios can be distinguished by their series numbers, 101 and above. This series contains a selection of charts from one or more of the complete folios; chart folios 71 and 72, for example, are the complete chart folios for the North and South Islands respectively of New Zealand, and chart folio 171 is the number of the abridged folios covering the same area. Abridged chart folios contain only a portion of the charts supplied in the complete chart folio, and consist of the ocean charts and probably a few of the large scale charts covering the major ports in the area.

In addition to the complete and abridged chart folios, there are "local" or "special" chart folios for issue to minor war vessels or dockyard craft working in the vicinity of dockyard ports. These are in the 300, 400 or 500 series. A small vessel working in the Portsmouth area would be supplied with chart folio 302—*North Foreland to Dartmouth*. The 300 series also includes special folios containing lattice, wreck, and operational charts. Lists of chart folios are given in the *Hydrographic Supplies Handbook* (H.51).

Special folios (called "large envelopes"), containing miscellaneous charts, diagrams, and tables of use to the navigator which are not included in any other folio or publication, are also supplied. These are H.92 (complete set), and H.134 (abridged set), and the contents of these folios are given in the *Hydrographic Supplies Handbook* (H.51).

Notices to Mariners and Correction of Charts

NOTICES TO MARINERS

The sea bed and coasts all over the world are constantly changing their form in one way or another, and to ensure safe navigation and pilotage these changes must be notified to the mariner wherever he may be. This is done by means of *Admiralty Notices to Mariners*, published and distributed by the Hydrographer. They contain the latest information on all navigational subjects, include corrections to charts and other hydrographic publications, and are issued in the following forms:—

The Weekly Complete Edition, which is printed on white paper and is intended for H.M. ships, and merchant ships for general use. It contains notices of the publication of new charts, new editions or reprints of existing charts, and notice of the publication of any hydrographic books, such as a new edition of a Volume of the *Admiralty Sailing Directions*; and it includes miscellaneous information of interest and importance to the mariner. It also contains corrections to charts and to the *Admiralty List of Lights*, and to the *Admiralty List of Radio Signals*.

The Weekly Home Edition, which is printed on green paper and is intended for small craft, merchant ships and fishing vessels serving in Home Waters. It covers an area which comprises the British Islands, Greenland, Iceland, Spitzbergen, the Faeroes, Arctic Ocean and Norway, North Sea and eastern shores, and the western coasts of Europe from the North Cape to Gibraltar.

The Quarterly Edition.—This is printed on white paper and is intended for issue to foreign-going ships of the Merchant Navy.

Fleet Notices, which contain confidential information used to correct Fleet charts. These charts and Fleet Notices are issued only to H.M. ships. The notices are printed in violet to distinguish them from Admiralty Notices which are in ordinary black type.

Admiralty Notices to Mariners are sent direct from the Hydrographic Supplies Establishment at Taunton to H.M. ships, chart depots, chart agencies and other distributing centres. They are obtainable from chart depots, chart agencies, Customs Houses, mercantile naval offices in Great Britain, and from the chief shipping offices at home and abroad.

CORRECTION OF CHARTS

Hand correction of charts should be made in waterproof violet ink, except for preliminary or temporary notices which should be entered in pencil. The reason for using violet ink is to ensure that any corrections made are distinctive from the original black print of the chart, especially under the orange artificial lighting common in most charthouses.

Erasures of any sort (except the erasures of pencilled corrections) should never be made on a chart. Any obsolete details should be ruled out in violet ink.

As far as possible any writing should be entered clear of the water area, and details such as cautionary notes and tidal information should be inserted in a convenient but conspicuous space, preferably near the title.

When a correction has been inserted the number of the relevant Notice to Mariners should be inserted against the year at the bottom left hand corner of the margin.

The recognised symbols and abbreviations (as shown on *Chart No. 5011*) should always be used. Examples of these are shown in Figs. 361 to 364.

Sometimes, when a great many new details have to be inserted in a small area, the notices contain a small portion of a reproduction of the chart, with the new information on it, which can be cut out and pasted over the appropriate place on the chart. Two points must be borne in mind: anything *written in pencil* which you are about to cover up must first be transferred to the "block" (as the new bit is called), and *the paste must be put on the chart*, not on the block which it would tend to pull out of shape.

If new information is not expected to apply for any length of time, or if it might have to be altered before being given in its final form, it will be labelled "temporary" or "preliminary" and must be put on the chart in pencil so that it can be rubbed out if necessary. Such notices are clearly marked (T) or (P), and a list of those still in force is included in the last issue of each month of the Weekly Edition.

All Notices to Mariners are numbered consecutively from No. 1 upwards throughout the year and are arranged in weekly bound copies also numbered by the week.

Other Hydrographic Publications

There are many other publications of value to the mariner, the more important of which are :—

The Admiralty Sailing Directions (known as “Pilots”), which give detailed information of the seas, coasts and harbours of the world, including meteorological information and notes on other phenomena. They are published in about 75 volumes, divided into the areas covered by the 87 folios of charts. These “Pilots” amplify the information supplied on a chart and they should be studied in conjunction with their relative charts whenever planning any passage. New editions are published about every 12 years and existing editions are kept up-to-date by the issue of yearly supplements which should always be studied whenever the book is consulted.

The Admiralty List of Lights, which is published in 12 volumes and tabulates the different kinds of navigational light to be found all over the world, giving exact details about each light and the building on which it stands. The only kind of light not described in these “Light Lists” is the light buoy, for which the largest scale chart and the appropriate “Pilot” must always be consulted. Light Lists are reprinted at the rate of one volume every month, *i.e.* the complete set is reprinted in an annual cycle.

The Admiralty List of Radio Signals, which is published in 3 volumes and describe and tabulate the many forms of radio aids for the mariner, such as broadcasts and weather information, Decca, and Loran Systems, direction finding and wireless bearing systems, etc. These are reprinted yearly.

The Nautical Almanac, which is a book compiled by the Astronomer Royal and issued yearly. It gives all astronomical data required by the mariner for navigational purposes.

The Nautical Tables, which is a book giving the various mathematical and astronomical correction tables required by the mariner.

The Admiralty Tide Tables, which are published annually by the Hydrographer and contain all information necessary to predict the height of tide at most places on the coasts of the world.

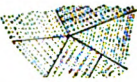
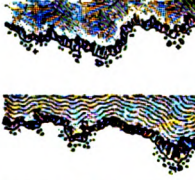
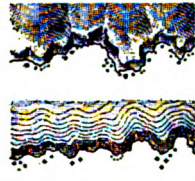
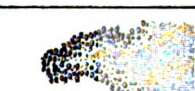
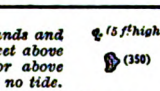
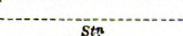
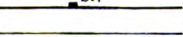
Chart Features	
Trees Nipa Palms Firs Palms Casuarinas	International Boundary — — — — —
Cultivated Land 	Signifies 1 fathom line 2 3 4 5 6 10 20 50 100 200 500 1,000 5,000 (new) (old)
Swamp or Marsh (salt or fresh) or Mossy Land 	* Only employed on lithographic plates; such fathom lines will be backed by a ribbon of flat tint.
Sand Hills or Dunes 	* Rocky Ledges & isolated rocks, dry at Mean Low Water Springs or at the level of the datum of the chart. Dries 2 ft. Dr. 3 ft. Dr. 1 ft.
Cliffy Coast line 	* Sandy Beach & Banks, dry at Mean Low Water Springs, or at the level of the datum of the chart. Dr. 1 ft. Dries 1 ft.
Steep Coast 	* Stones, Shingle or Gravel, dry at Mean Low Water Springs or at the level of the datum of the chart. Dries 2 ft.
Sandy Coast 	* Mud Banks, dry at Mean Low Water Springs, or at the level of the datum of the chart.
Stony or Shingly Coast 	* Sand & Gravel or Stones, dry at Mean Low Water Springs, or at the level of the datum of the chart.
Mangroves 	* Sand & Mud, dry at Mean Low Water Springs, or at the level of the datum of the chart.
Figures bracketed against islands and rocks express the Heights in Feet above Mean High Water Springs, or above the sea in cases where there is no tide. Heights on the land are bracketed when they are removed from the object to which they refer. (5 ft high) (350)	* The Underlined Figures, on the Rocks & Banks which uncover, express the heights in feet above the datum of the chart, unless otherwise stated.
Towns, Villages or Houses 	
Villages or Houses 	
Roads 	
Track or Footpath 	
Railway 	
Tramway 	

Fig. 361. Conventional signs used on charts

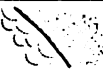
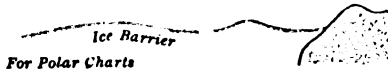
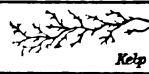
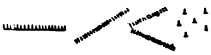
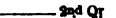
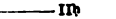
Chart Features, Fog Signals, Radio Stations and Wrecks																													
Submarine Sound Signal not emitted from a light vessel  Church or Chapel  Buddhist Temple  Shinto Shrine  Mosque  Moslem Tomb  Windmill  Triangulation Station Beacon, Chimney, Flagstaff or other fixed points  Coral Reefs  Rock awash at the datum of the chart or with less than 6 feet of water at the datum of the chart or small isolated rock in exposed position or rock ledge on which depths are known in general to be less than 6 feet.  On older charts the symbols  and  are used for rock awash at the level of the datum of the chart. Rocks with limiting Danger line  Rock or Shoal, the Position of which is Doubtful   Reported Rock or Shoal, the Existence of which is Doubtful    Breakers along a shore  Ice Barrier For Polar Charts  Overfalls & Tide Rips Eddies  Signifies depth to which an obstruction or even has been swept by wire drag   Signifies no bottom found at the depth expressed  10 100 Fishing Stakes  Submarine Cable Power Cable  (The word "Overhead" and the height in feet above H.W. are added where necessary on the largest scale charts.)	Anchorage  For small vessels * Discontinued 1937 Fog Signals <table border="1"> <thead> <tr> <th>Air Signals</th><th>Submarine Signals</th></tr> </thead> <tbody> <tr> <td>Nauto. Nautophones</td><td>S.O. Oscillator</td></tr> <tr> <td>Siren Siren</td><td>S.B. Bell</td></tr> <tr> <td>Dia. Diaphone</td><td></td></tr> <tr> <td>Reed Reed</td><td></td></tr> <tr> <td>Gun Gun</td><td></td></tr> <tr> <td>Explos. Explosive</td><td></td></tr> <tr> <td>Whis. Whistle</td><td></td></tr> <tr> <td>Bell Bell</td><td></td></tr> <tr> <td>Gong Gong</td><td></td></tr> </tbody> </table> Symbols used prior to 1928 <table border="1"> <thead> <tr> <th>Sub Fog Sig</th><th>Submarine Fog Signal</th></tr> </thead> <tbody> <tr> <td>S.F.B.</td><td>Submarine Fog Bell</td></tr> <tr> <td>S.B.</td><td>Submarine Bell</td></tr> <tr> <td>Sub Bell</td><td>(worked by wave action.)</td></tr> </tbody> </table> Radio Stations - W/T Radio Telegraph Station - W/TDF Radio Direction Finding Station - W/T.B. Radiobeacon - R/T Radio Telephone Station R. Coast Radio Station which transmits on request ("QTG") for the use of ships' D.F. - R.B. Radiobeacon - R.D.F. Radio Direction Finding Station - R.M. Radio Mast Radio IT } Mast or lattice towers of a radio station forming a conspicuous landmark Radar Stations - Ra. Coast Radar Station - Racon Radar Responder Beacon - Ramark Radar Beacon (Continuous) - Ra Ref Radar Reflector - Ra (conspic) Radar Conspicuous Object Note:—Outer circles are in magenta Wrecks Visible Wreck showing any portion of the hull or superstructure (not masts, derricks, funnels, or ventilators only) above low water.  Submerged (a) Wreck over which the exact depth of water is unknown but which is considered dangerous to surface navigation.  (b) Wreck over which the exact depth of water is known.  (c) Wreck over which the exact depth is unknown but which is not considered dangerous to surface vessels capable of navigating in the vicinity.  Wreck Remains * Remains of a wreck no longer dangerous to surface navigation but to be avoided by vessels anchoring, trawling, etc.  Old Wreck Partially or wholly submerged wreck Symbols over which the depth is unknown.  Note:—On large scale plans, on which the wrecks are frequently delineated in outline, visible wrecks (as defined above) are shown in firm outline, and submerged wrecks in pecked outline, such outlines being marked "Wreck". In the case of submerged wrecks whether delineated in outline, or shown by a symbol, where it is known that masts and/or funnels are visible, a note to that effect may be inserted, e.g. — Wreck (Mast 5 feet) (Funnel) (Masts and funnels) (Mast, dries 7 feet) * Where the depth over a wreck exceeds 4 fathoms or a wreck is considered non-dangerous the corresponding symbol is generally given on the latest scale charts only.	Air Signals	Submarine Signals	Nauto. Nautophones	S.O. Oscillator	Siren Siren	S.B. Bell	Dia. Diaphone		Reed Reed		Gun Gun		Explos. Explosive		Whis. Whistle		Bell Bell		Gong Gong		Sub Fog Sig	Submarine Fog Signal	S.F.B.	Submarine Fog Bell	S.B.	Submarine Bell	Sub Bell	(worked by wave action.)
Air Signals	Submarine Signals																												
Nauto. Nautophones	S.O. Oscillator																												
Siren Siren	S.B. Bell																												
Dia. Diaphone																													
Reed Reed																													
Gun Gun																													
Explos. Explosive																													
Whis. Whistle																													
Bell Bell																													
Gong Gong																													
Sub Fog Sig	Submarine Fog Signal																												
S.F.B.	Submarine Fog Bell																												
S.B.	Submarine Bell																												
Sub Bell	(worked by wave action.)																												

Fig. 362 (cont.) Conventional signs used on charts

Tides and Tidal Streams

M.H.W.S.....	Mean High Water Springs	} Mean Heights where tide is semidiurnal
M.H.W.N.....	Mean High Water Neaps	
M.L.W.S.....	Mean Low Water Springs	
M.L.W.N.....	Mean Low Water Neaps	
M.H.H.W.....	Mean Higher High Water	} Average daily heights where the diurnal inequality is large or the tide is diurnal.
M.L.H.W.....	Mean Lower High Water	
M.L.L.W.....	Mean Lower Low Water	
M.H.L.W.....	Mean Higher Low Water	
Fl., ft.....	Flood	m..... minutes
H.W.....	High Water	Np..... Neap Tides
h.....	hour hours	Qr..... Quarter
kn.....	knot, knots	Sp., Spr..... Spring Tides
L.W.....	Low Water	§  Current
I.S.L.W.....	Indian Spring Low Water	→..... Flood Stream
(For definition see Admiralty Tide Tables, Part III)		→..... Ebb "
M.T.L.....	Mean Tide Level	M.S.L..... Mean Sea Level
⬠ ⬡ ⬢ etc.. Chart gives information regarding the Tidal Streams at the pos ^{ns} occupied by these symbols.		

† The period of the tide at which the streams are running in the direction of the arrows is denoted as follows:—

- ① 1st Qr, 2nd Qr, etc. for the Quarters of each Tide.....  2nd Qr  2nd Qr
- ② 1st 1sth 1sth etc. for 1st 2nd 3rd 4th hours after High or Low Water.....  1sth  1sth
- ③ Black dots on the arrows, the number of hours after High or Low Water.....  1sth  5thh

§ The Rate of Currents and Tidal Streams is expressed in knots, thus:—

 1 kn  5 kn

†* The use of these terms is being discontinued.

Buoys and Beacons

Light Buoys	  	Buoys with Topmarks	   
Gong Buoys	  	Spar Buoys, Pillar Buoy	  
† Bell Buoys	   Symbol prior to 1942 	Mooring Buoys	   
* Can Buoys	   B.W. B.W. B.W.	Fixed or Floating Beacons	   
* Conical Buoys	   B.W. B.W. B.W.	Light Vessels or Floats	  
* Spherical Buoys	  B.W. W		

The Position of a Light Vessel, Buoy or Beacon is the Centre of the Base, and is usually indicated by a small circle.

B., Blk....Black
Cheq....Chequered
G.....Green
Gy.....Gray
H.S....Horizontal Stripes
N9.....Number

Ref.....Reflector
R.....Red
Bl.....Blue
V.S....Vertical Stripes
Y.....Yellow
W., Wh....White

The Heights given against Beacons and marks thus:— • B₀ (35) • C₁ (156) represent the Height of the Top of the object above Mean High Water Spring Tides, or above the Sea level where there is no tide

Colours of Buoys are shown in alphabetical order.

† For Automatic Bell Buoys period & number of strokes shown thus:— Bell (2) 90 sec.

* In the case of two-colour buoys each colour is indicated below the appropriate symbol.

On certain older charts the symbols H.S., V.S., & Cheq. appear in addition.

Fig. 363 (cont.) Conventional signs used on charts

Lights	
★ * Lights, Position of	Qk. Fl. Quick Flashing
Lt, Ltp Light, Lights	Int. Qk. Fl. ... Interrupted Quick Flashing
† Lt Alt. Alt. Light Alternating	
Lt F. F. Fixed	Gp. Int. Qk. Fl. ... Group Interrupted Quick Flashing
Lt Fl. Fl. Flashing	† Alt. alternating
Lt Occ. Occ. Occulting	fl. fl. flash, flashes
FL (S-L) " Flashing (Short and Long flashes)	Gp. Group
Lt F. Fl. F. Fl. Fixed & Flashing	hor. horizontal (Lights placed horizontally)
* Lt Gp. Fl. (3) Gp. Fl. (3) Group Flashing	irreg. irregular
* Lt F. Gp. Fl. (4) F. Gp. Fl. (4) Fixed & Group Flashing	m M. miles
* Lt Gp. Occ. (2) Gp. Occ. (2) Group Occulting	min. minute or minutes
Gp. Fl. (S-L) " Group Flashing (Short and Long flashes)	obsc. obscured
* Air Gp. Fl. (AB) " Air Light Flashing --	! occas. occasional
	sec. second or seconds
	(U) Unwatched
	vert. vertical (Lights placed vertically)
	vis. visible (now obsolete)
Colours of lights	
.....Bl. Blue	Vi. Violet or Purple
G. Gp. G. Green	W., Wh. W. White
.....Or. Orange, Yellow or Amber	
R. R. Red	
★ Gp. Occ. (2) W. R. 5 sec. 130 ft. 12 M. (U) Example of full abridged description of light.	
† Alt. (Alternating) signifies a Light which alters in colour.	
* The number in brackets after the description of Group Flashing or Group Occulting Lights, denotes the number of flashes or eclipses in each group. The characteristics of Air Lights which exhibit groups of flashes representing letters of the Morse Code are shown by the appropriate letters in brackets.	
! Occasional Light or Fog Signal is a signal which is only given when a vessel is expected or in answer to vessels signals or at other irregular times.	
The height given against a light is the height of the focal plane of the light above Mean High Water Spring Tides, or above the Sea level in cases where there is no tide.	
The visibility of lights is given in nautical miles, assuming the eye of the observer to be 15 feet above the sea.	
Bearings of Lights are given from Seaward.	
General Remarks	
MERIDIANS. Charts are generally drawn on the True Meridian; if otherwise, a True Meridian is given on the chart.	
LONGITUDES. All Longitudes are referred to the Meridian of Greenwich.	
SOUNDINGS. Soundings are expressed in Feet or Fathoms, as stated in the title of the chart. 1 Fathom = 6 Feet = 1.828798 Metres.	
On charts published after 1922 soundings of under 11 fathoms (20m 1) are shown in fathoms and feet, instead of in fathoms and fractions of a fathom thus:—	
The sounding 8½ represents a depth of 8 fathoms 5 feet (16m 2).	
" " 0½ " " " " 0 fathoms 3 feet (0m 9).	
The centre of the space occupied is the position of the depth indicated.	
DRYING HEIGHTS. Underlined Figures, on Rocks and Banks which uncover, express the Heights in Feet above the Datum of the Chart, unless otherwise stated.	
HEIGHTS. All Heights (except those expressed in underlined figures as above) are, unless otherwise stated, given in Feet above Mean High Water Springs, or, in places where there is no tide, above the Level of the Sea.	
SCALES. The Natural Scale is the proportion which any measurement on the chart bears to the actual distances represented, and is shown thus:— 1/150.	
A Sea Mile is the length of a minute of Latitude at the place, and a Cable is assumed to be a tenth part of a Sea Mile.	
DIMENSIONS OF PLATE. The Figures in Brackets in the bottom right hand corner of a chart, thus:—(30.43x25.49) are the dimensions of the plate in Inches between the innermost graduation or border lines.	
DATES OF CHART CORRECTIONS. For the method of dating charts for corrections see Introductory chapter in Admiralty Sailing Directions.	
NAMES. Alternative names are indicated by the use of the word "or". Names shown in brackets are generally obsolete names to read with the Admiralty S.D. of an earlier date, but occasionally they are conventional names or new names.	

Fig. 364 (cont.) Conventional signs used on charts

CHAPTER XXIV

Tides and Tidal Streams

TIDES

THE periodic rise and fall of the level of the sea constitute what are known as tides. The rise or fall does not occur simultaneously over the surface of an ocean or sea, but appears to radiate outwards from some central area in that ocean or sea, as does the ripple caused by a stone thrown into a pond. The periodic rise and fall of tides are fairly regular, and therefore the height of a tide at any particular time and place can be predicted with a reasonable degree of accuracy.

Causes of Tides

The force which governs the periodic heaping up and subsequent subsidence of the water in an ocean is composed of the following elements :—

- (i) the attractive force of the Moon ;
- (ii) the attractive force of the Sun ;
- (iii) the gravitational force of the Earth ;
- (iv) the centrifugal force caused by the rotation of the Earth about its axis.

Of these contributory forces that of the Moon is greatest. But for the effects of the shape and depth of the oceans, and the positions of islands therein and the shape of the coastlines, the rise and fall of the tides would closely follow the movement of the Moon round the Earth, varied to some extent in accordance with the momentary position of the Moon, the Earth and the Sun in relation to each other. In fact, however, the manner in which the tides rise and fall in different seas and oceans varies considerably ; the period of oscillation of the tide in one area differs from that in another, and varies from about 6 to 24 hours. A 24-hour period of oscillation, called a "diurnal" (or daily) tide, would result in one high water and one low water a day ; a 12-hour period, called a "semi-diurnal" (or half-daily) tide, would result in two high waters and two low waters a day ; while a 6-hour period would result in four high and four low waters a day.

The term tide includes one complete cycle of one high water and the succeeding low water. It is therefore incorrect to refer to the state of a particular tide as " high tide " or " low tide ", when what is really meant is " high water " or " low water ". The description " high tide " would compare the height of that particular tide with that of some previous one.

The Tide Wave

In many areas the tide wave appears to advance from the centre of an ocean along the surrounding coasts.

The advance of the tide wave around the coasts of Great Britain is illustrated in Fig. 365 ; this tide has a period of oscillation of about 12 hours and moves approximately as follows :—

- at zero + 2 hours, it arrives off the coast of Portugal ;
- at zero + 3 hours, it arrives off the western coast of France ;
- at zero + 4 hours, it arrives off Land's End.

At Land's End part of the tide wave travels up the Channel and reaches the Straits of Dover at zero + 11 hours, while the remainder continues northward up the west coast of Eire until :—

at zero + 9 hours, it arrives west of the Orkney Islands, and then passes into the North Sea ;

at zero + 12 hours, it arrives off Peterhead ;

at zero + 24 hours, it arrives off Harwich.

Off Harwich this tide wave meets its successor, which set out from mid-Atlantic at about zero + 12 hours and had travelled up the Channel through the Straits of Dover in the intervening period.

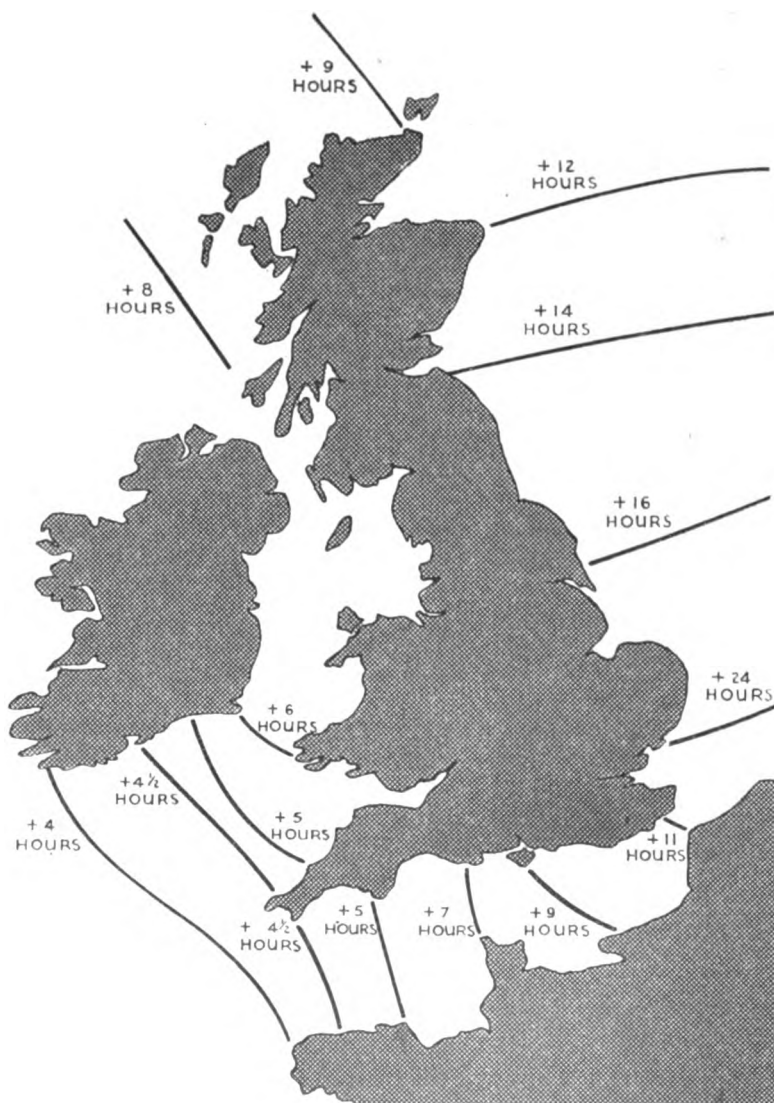


Fig. 365 Approximate advance of tide-wave around Great Britain

Springs and Neaps

The combined attractive forces of the Moon and the Sun on the Earth's large masses of water have their greatest effect when they are in line with the Earth, *i.e.* at new moon and full moon, and their least effect when they are approximately at right angles to each other, *i.e.* at the first and last quarters of the moon ; this is depicted diagrammatically in Fig. 366. (See also " Phases of the Moon " on page 707.)

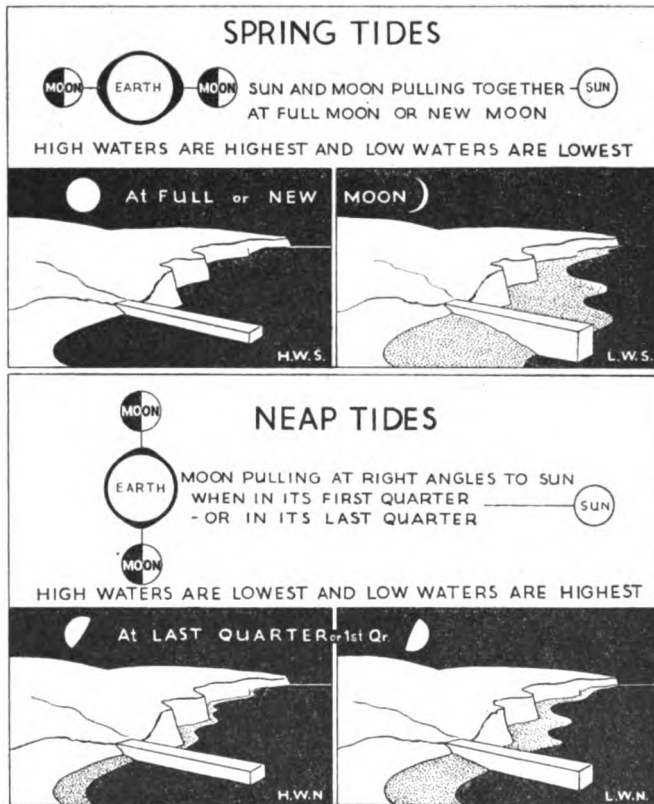


Fig. 366. Spring and neap tides

These variations of this force affect the height of the tide wave they produce and hence the range of the tide, *i.e.* the difference in level between successive high and low waters, is also affected. Shortly after full and new moon a locality will experience its highest high waters and lowest low waters of that lunar month, and the tides at this period are called "spring tides". Conversely, around the times of first and last quarters of the Moon, the lowest high waters and highest low waters of that lunar month will be experienced, at which period the tides are called "neap tides". Between these limits the heights of successive tides increase or diminish progressively. Spring tides around the British Isles occur at from about one to one and a half days after full or new moon, and neaps occur at about the same interval after the first or last quarters of the Moon. The time interval between successive spring and neap tides is

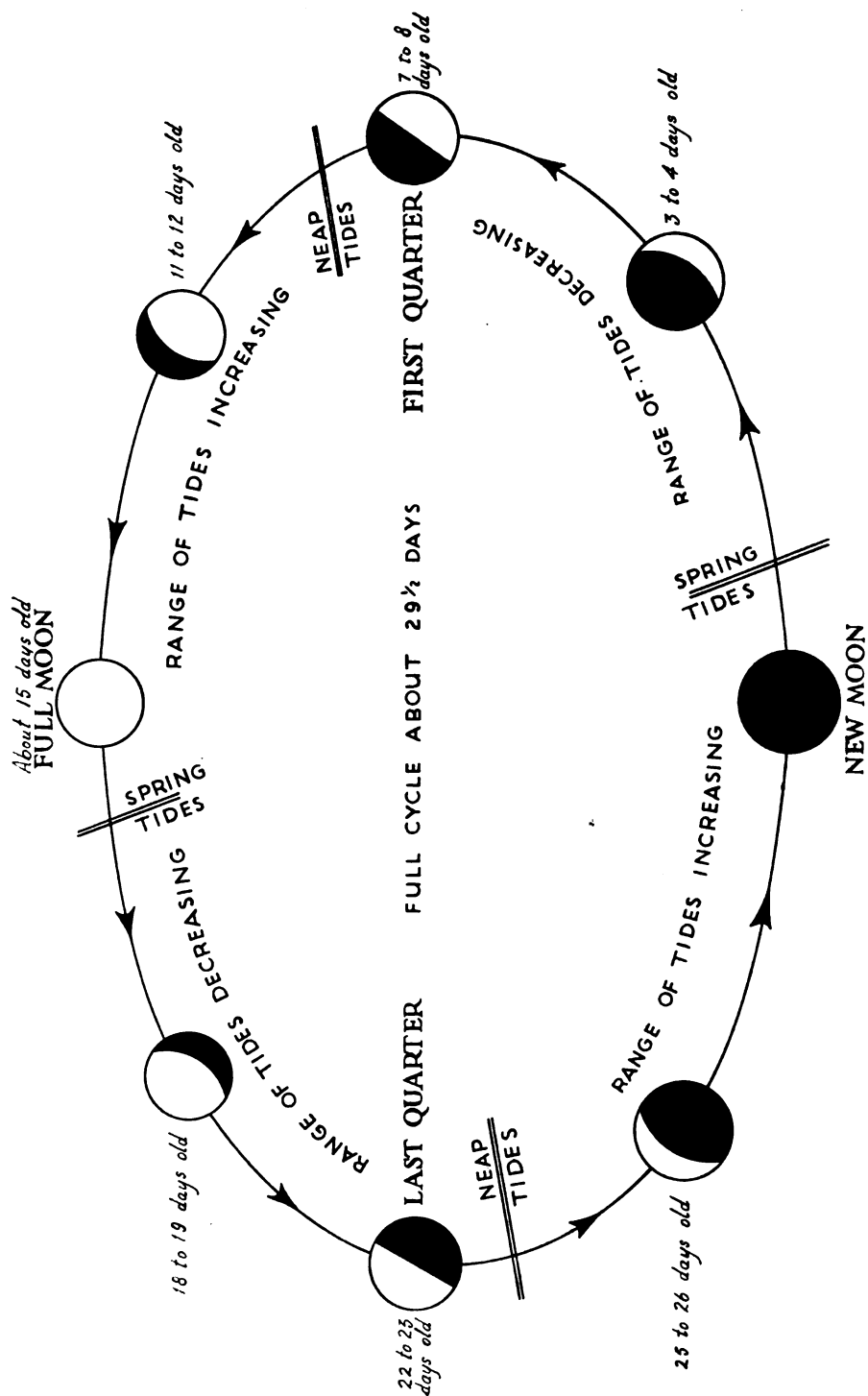


Fig. 367. Spring and neap tides in British Isles relative to phases of the Moon

variable, but for practical purposes it can be taken as being about $7\frac{1}{4}$ days (*i.e.* about one quarter of an average lunar month of $29\frac{1}{2}$ days). A pictorial representation of the moon and tide cycle as experienced in the British Isles is shown in Fig. 367.

Local Tides

As previously mentioned, the tides experienced in one locality may differ considerably in period from those experienced in another. Such differences may be apparent at places quite close to each other ; for instance, although the tides around the British Isles are semi-diurnal in character, some places, of which Poole and Southampton are examples, may experience four high and four low waters a day. In other parts of the world, some parts of the Pacific Ocean for example, a diurnal tide (*i.e.* a tide with only one high water and one low water a day) may be experienced, and many localities in the Mediterranean Sea experience little or no appreciable tide.

Local knowledge of tides is therefore of great importance to the seaman, and before visiting a strange port he should consult the *Admiralty Tide Tables* to ascertain the behaviour of the tides in that locality. Tidal data, compiled from astronomical calculations and actual observations over a long period, are published yearly in these tables, and from them the actual state of the tide at any major port on any day and any time can be predicted with a reasonable degree of accuracy.

Effects of Weather on Tides

The type of local weather experienced may appreciably alter the level of waters in the locality, especially in estuaries such as the Solway Firth, Bristol Channel and Thames Estuary. For example, continuous heavy rain inland may cause the flooding of rivers and a consequent rise in the water level of the estuary into which they flow. Again, prolonged gales blowing from the same quarter will tend to raise the sea level ahead of them, and lower it behind them, especially in shoal waters. Low barometric pressure also tends to raise the sea level, and high barometric pressure tends to lower it.

Interval Between Tides

The interval of time between one high water and the corresponding high water on the following day depends to a large extent on the period of a lunar day, which is about 24 hours, 50 mins. As a rough guide it can be taken that, with a tide whose period of oscillation is regular, high water will occur about 50 minutes later each day.

The interval of time between successive high and low waters will of course depend upon the period of oscillation of the parent tide. For a tide with a 12-hour period (such as that experienced around the British Isles) the interval between successive high waters would be about 12 hours 25 minutes, while the interval between one high water and the succeeding low water would be about 6 hours 12 minutes.

Ebb and Flood, Range and Stand

The rising tide is called the "flood tide" and the falling tide is called the "ebb tide", but care should be taken not to confuse these terms with the "flood

stream" and the "ebb stream"; whereas the term "tide" describes a vertical movement of the sea, the term "stream" describes the horizontal movement of the sea caused by a tide. The "range" of any tide is the difference between the levels of successive high and low waters, and the "stand" of a tide is the period at high or low water during which no rise or fall can be detected. The occurrence and period of the stand in different parts of the same locality may vary considerably, because they are affected by the formation of the sea bed and the coast, and by the presence of rivers and streams; local knowledge of these features is therefore of great value.

The rate of rise or fall of a tide will not be uniform, and the extent of the rise or fall every hour will depend on the interval between low and high water. A rough guide to the rise or fall of a 6-hourly tide is given below, but it is emphasised that this method of estimating the approximate height of the tide at any particular time should not be used if *Admiralty Tide Tables* are available, because the results are by no means accurate (see also Fig. 368).

A 6-hour tide may be expected to rise or fall for approximately :—

- 1/12th of its range in the first hour ;
- 2/12ths of its range in the second hour ;
- 3/12ths of its range in the third hour ;
- 3/12ths of its range in the fourth hour ;
- 2/12ths of its range in the fifth hour ;
- 1/12th of its range in the sixth hour.

It will be seen that the maximum rate of rise or fall occurs at half tide, and it follows that connections between ship and shore, such as breast ropes and brows, require particular attention at half flood and half ebb. On the other hand the adjustment of berthing hawsers should be made at high or low water to allow for the range of the tide.

Grounding

The extent of the damage a vessel will suffer through grounding in tidal waters depends upon her construction, the weather, and the nature of the bottom; if still sufficiently water-tight, her prospects of floating off again with the return of the tide are as follows :—

- a vessel grounding on a rising tide will probably soon refloat ;
- a vessel grounding on a falling tide, say an hour after high water, will not float again until one hour before the next high water, *i.e.* about ten hours later in the British Isles ;
- a vessel grounding at the top of high water, say two days after springs, should not expect to float without assistance until about two days before the next springs, *i.e.* about ten days later.

In the above examples it is assumed that meanwhile the ship is not driven further on to the bank or shoal by wind and sea, and that no abnormal tides are experienced.

Tidal Definitions

Knowledge of the following tidal definitions is required for chartwork and for use of the Tide Tables. They are illustrated in Fig. 368 which shows a tide-

pole graduated in feet placed where the charted depth is two feet and on a day when the rise of the tide is say 19 feet.

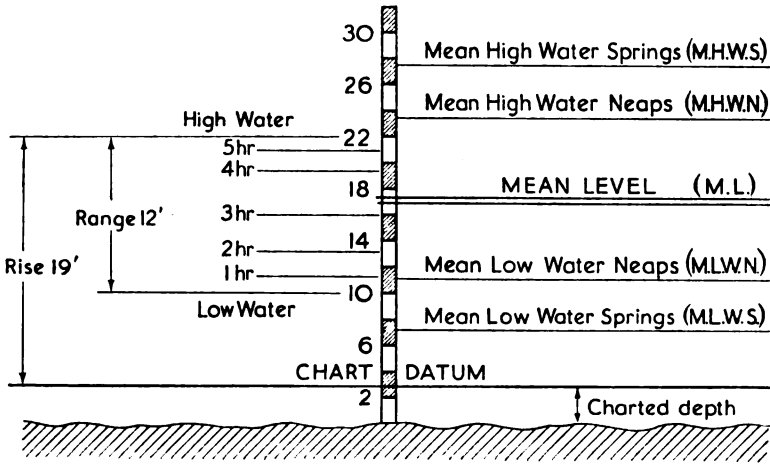


Fig. 368. Tidal definitions

Mean Level (M.L.) is the average level of the surface of the sea.

Tidal Oscillation. A tide wave represents one vertical oscillation about the mean level of the sea, and, as shown in Fig. 369, it includes one high water and the succeeding low water.

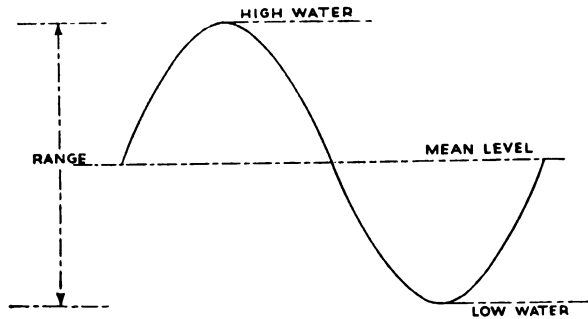


Fig. 369. Graph of tidal oscillation

High Water (H.W.) is the highest level reached by the surface of the sea in one tidal oscillation.

Low Water (L.W.) is the lowest level reached by the sea in one tidal oscillation.

Mean High Water Springs (M.H.W.S.), and **Mean High Water Neaps (M.H.W.N.),** are the average heights of high water at springs and neaps, taken over a long period.

Chart Datum is the level below which depths are given on the chart, and above which the height of the tide is measured; the height of the tide at any moment must therefore be added to the charted depth to give the actual depth or sounding. The chart datum is selected during the initial survey of any area, and varies from place to place depending upon the range of the tide in the area. It may be taken as a height below which the tide at that place seldom falls.

The Rise of a tide is the height of its high water above chart datum.

Tidal Information on Charts

The depths on a chart show the depths of water *below chart datum*, that is to say they give the least depths of water to be expected under average circumstances. The chart datum, and, where applicable, the heights of high and low water above chart datum at mean springs and neaps, will be found near the title of the chart. If the height of mean sea level (M.L.) is added to the charted depths the result will give the average depth of water which may be expected at half tide.

On certain large scale charts where the tide has a 12-hour period, the rise of the tide (*i.e.* its height above chart datum) is given for mean springs and neaps, and, if the age of the Moon is known, the height of high or low water on any one day can be roughly estimated from this information, but it is emphasised that this estimation should only be used if the *Admiralty Tide Tables* are not available. In this case springs can be assumed to occur one to two days after new or full moon, and neaps about midway between successive springs; and the rise may be assumed to change regularly between springs and neaps, and *vice versa*.

Thus, to find the approximate height of high water, take $1/7$ th of the difference between the heights of M.H.W.S. and M.H.W.N., multiply the result by the number of days interval from springs, and subtract this result from the height of M.H.W.S.

To find the approximate height of low water, subtract the height of high water from twice the height of the mean level.

Example.—The heights of high and low water off a port on the south-west coast of England on a certain day are required; the day in question is three days before new moon, *i.e.* about $4\frac{1}{2}$ days from springs:—

	<i>feet</i>
Spring rise (from chart)	17.0
Neap rise (from chart)	13.7
Difference	3.3
$4\frac{1}{2} \times 1/7$ th of difference	2.1
H.W. height	14.9
$2 \times$ M.L. (from chart)	20.2
L.W. height	5.3

Therefore: H.W. height = 14.9 ft. and L.W. height = 5.3. ft.

If the time of high or low water is known, the height of the tide for a particular time can be roughly estimated by applying the rough guide for the hourly rate of rise or fall. It is emphasised that this method should not be used if *Admiralty Tide Tables* are available.

Example.—If the time of high water in the previous example were 0630, what would be the height of the tide at 0830?

	<i>feet</i>
H.W. height	= 14.9
M.L. (from chart)	= 10.1
Range	= $4.8 \times 2 = 9.6$
Interval from H.W.	= 2 hours
Fall for first hour	= $\frac{1}{12} \times \frac{9.6}{12} = 0.8$ feet
Fall for second hour	= $\frac{2}{12} \times \frac{9.6}{12} = 1.6$ feet
Total fall	= 2.4 feet

Therefore height of tide at 0830 = $14.9 - 2.4$
= 12.5 feet.

Note.—Such heights are in practice calculated to the nearest foot.

The Admiralty Tide Tables

These are published annually in three volumes, namely :—

- “ Volume A—European Waters ” ;
- “ Volume B—Atlantic and Indian Oceans ” ;
- “ Volume C—Pacific Ocean and Adjacent Seas ”.

Each volume is divided into two parts, namely :—

- “ Part I—Tidal Predictions for Standard Ports ”.
- “ Part II—Tidal Data for Secondary Ports ”.

Standard Ports.—A Standard port is one for which the times and heights of high and low water have been predicted for every day of the year.

Secondary Ports.—Each Standard port is allocated a number of Secondary ports, the tidal features of which are related to those of their parent Standard port. The data given in Part II of the Tide Tables include the differences between the times and heights of high and low water at the Secondary ports and those at their parent Standard port.

Times.—All times in Volume A are Greenwich mean time (Zone zero), and will have to be corrected to the standard or zone time of the port concerned if it is not keeping G.M.T. (For descriptions of Greenwich mean time, standard time, and zone time, see Chapter XXVI.)

The times in Volumes B and C are given for a certain meridian or zone, as indicated at the foot of the relevant page, and these times may have to be corrected to the standard time of the port concerned.

The following examples are given to show how the *Admiralty Tide Tables* should be used to find the times and heights of high and low water at Standard and Secondary ports :—

Example 1.—“ What are the standard times and heights of high and low water at Portsmouth on June 3rd, 1950 ? ”

The index of Volume A of the *Admiralty Tide Tables* for 1950 shows that Portsmouth is a Standard port, tidal predictions for which appear in Part I of the volume.

Turning to Portsmouth (see Fig. 370), it is seen that on May 3rd there are two times of low water, but only one of high water, the previous high water having occurred shortly before midnight on May 2nd. The times

given in the Tide Tables, however, are G.M.T., whereas the standard time kept at Portsmouth at this time of the year is British Summer Time (— 1 hour), and one hour must therefore be added to the times given in the Tide Tables. It will therefore be necessary to include the time of the last high water on May 2nd.

ENGLAND, SOUTH COAST—PORTSMOUTH

Lat. 50° 45' N. Long. 1° 05' W.

TIME ZONE : Greenwich.

MONTH DAY	WEEK DAY	MAY						WEEK DAY	JUNE						WEEK DAY	JULY					
		HIGH WATER			LOW WATER				HIGH WATER			LOW WATER				HIGH WATER			LOW WATER		
		Time	Ht.		Time	Ht.			Time	Ht.		Time	Ht.			Time	Ht.		Time	Ht.	
		H. M.	F.		H. M.	F.			H. M.	F.		H. M.	F.			H. M.	F.		H. M.	F.	
1	M	1024	13.5		0319	0.2		M	1144	13.3		0431	0.4		S	—	—		0510	0.1	
2	T	2247	14.2		1540	0.4		F	—	—		1655	0.2		S	1228	13.0		1735	0.7	
3	W	1118	14.3		0406	0.7		S	0001	13.5		0520	0.4		S	0038	12.8		0557	0.2	
4	Th	2334	14.3		1827	0.8		S	1237	13.2		1743	0.5		M	1315	13.1		1820	1.0	
5	F	1158	13.9		0451	0.9		S	0049	13.1		0607	0.2		M	0123	12.5		0642	0.1	
		—	—		1713	0.6		S	1327	12.9		1830	0.9		T	1403	12.9		1906	1.3	
		0020	14.3		0530	1.0		S	0137	12.6		0652	0.3		T	0206	12.1		0725	0.6	
		1246	13.5		1756	0.4		M	1418	12.6		1920	1.6		T	1447	12.5		1951	1.8	
		0105	13.5		0619	0.6		M	0225	11.9		0741	1.0		W	0249	11.8		0807	1.2	
		1335	13.0		1840	0.5			1511	12.1		2012	2.3			1532	12.1		2036	2.4	

Fig. 370. Excerpt from Admiralty Tide Tables—Volume A, Part I

The standard times of high and low water at Portsmouth on May 3rd, 1950, are therefore calculated as follows :—

	May 2nd	May 3rd
G.M.T. of H.W.	= 2334	1158
Correction for B.S.T.	= 0100 +	0100 +
S.T. of H.W. May 3	= 0034	1258
	May 3rd	May 3rd
G.M.T. of L.W.	= 0451	1713
Correction for B.S.T.	= 0100 +	0100 +
S.T. of L.W. May 3	= 0551	1813

Against the heights of low water it will be seen that there is an asterisk. This indicates that they are the heights *below chart datum* and should be *subtracted*, instead of added, to the charted depths to give the actual height of low water.

Therefore the standard times and heights of high and low water at Portsmouth on May 3rd, 1950, are :—

H.W. 0034, 14.3 feet, and 1258, 13.9 feet ;

L.W. 0551, — 0.9 feet, and 1813, — 0.6 feet.

It follows that on May 3rd, 1950, at Portsmouth Harbour in a charted depth of 3 fathoms (18 feet) there is a depth of 32.3 feet at 0034, and a depth of 17.1 feet at 0551.

Example 2.—“ What are the local times and heights of the afternoon high and low waters at Barfleur on 16th January, 1950 ? ”

Barfleur is on the north coast of France, and it will be seen that in the index of Volume A of the *Admiralty Tide Tables* there is against Barfleur a number (1559), which shows that it is a secondary port.

On looking up Barfleur in Part II, it will be seen that Cherbourg is the standard port.

On looking up Cherbourg in Part I, it will be seen that the times and heights of high and low water for p.m. on 16th January, are :—

H.W. 1831—18.0 feet.

L.W. 1249—5.1 feet.

STANDARD PORT		Lat. N.	Long. W.	High Water		Low Water		High Water		Low Water	
1600	CHERBOURG	49° 39'	1° 38'	0900 and 2100	0300 and 1500	0300 and 1500	0900 and 2100	F. 20.7	F. 16.1	F. 3.0	F. 7.6
(see page 153)											
SECONDARY PORTS		TIME DIFFERENCES				HEIGHT DIFFERENCES					
FRANCE, NORTH COAST— <i>cont.</i>		N.	W.	H. M.	H. M.	H. M.	H. M.	F.	F.	F.	F.
1568	St Vaast la Hougue ..	49° 34'	1° 46'	+0 46	+0 51	+1 11	+1 27	+1.6	+1.0	+0.1	+0.1
1599	Barfleur	49° 40'	1° 15'	+0 44	+0 53	+0 41	+0 41	+0.3	+0.9	+0.3	0
1601	Omouville	49° 43'	1° 52'	-0 22	-0 27	-0 35	-0 33	-0.4	+0.1	+0.1	0
1602	Goury	49° 43'	1° 56'	-0 51	-1 07	-1 19	-1 25	+5.1	+4.9	-0.4	+2.1

Fig. 371. Excerpt from Admiralty Tide Tables—Volume A, Part II

On turning back to Barfleur in Part II (see Fig. 371) it will be seen that the time differences are related to specific times of high and low water at Cherbourg; also, that the height differences are related to specific heights of high and low water. Interpolation may be necessary between the respective times and heights shown if they differ appreciably from the actual times and heights on the day in question, or if great accuracy is required.

In this example the variation in time for high water amounts only to 7 minutes over a 6-hour period; and the variation in height for high water amounts to only 0.6 feet over a range of 4.6 feet, and for low water it is only 0.3 feet over a range of 4.6 feet.

The time 1831 lies at a little over half the interval between 1500 and 2100, so the time difference for H.W. should read + 0h 47m.

The height 18.0 feet lies at about one half of the way between 16.1 and 20.7 feet, so the height difference for H.W. should read + 0.6 feet.

The height 5.1 feet lies at a little less than half way between 3.0 and 7.6 feet, so the height difference for L.W. should read + 0.2 feet.

The times and heights of high and low water at Barfleur are therefore obtained by applying these differences to the times and heights at Cherbourg, as shown below :—

Cherbourg H.W.	...	...	1831	18.0 feet
Differences	...	...	+47	+0.6
Barfleur H.W.	...	...	1918	18.6 feet
Cherbourg L.W.	...	...	1249	5.1 feet
Differences	...	...	+41	+0.2
Barfleur L.W.	...	...	1330	5.3 feet

From the *Nautical Almanac* it will be seen that France keeps G.M.T. in the winter months, and so no time corrections are necessary.

Therefore local times and heights of high and low water at Barfleur on the afternoon of 16th January are :—

L.W.	1330	5.3 feet
H.W.	1918	18.6 feet

TIDAL STREAMS

Description, Definitions and Behaviour

Although the tide wave does not carry the water along with it, its passage along a coast does produce periodic horizontal movements of water, called "tidal streams", which flow in and out of harbours and along the coast, and are related to the rise and fall of the local tide. It must not be imagined, however, that a piece of wood floating in mid-Atlantic will reach Portugal in two hours, and Land's End two hours later, in accordance with the progress of the tide wave ; but a baulk of timber carried out of harbour on the outgoing stream might reasonably be expected to return again on the ingoing stream, except where a strong river current meets tidal water in the harbour, or where other currents outside carry the timber away or wash it ashore meanwhile.

A rising tide in harbour is accompanied by what is often called the "flood stream", and a falling tide by what is often called the "ebb stream". As, however, neither the flood nor the ebb streams necessarily change their direction at the times of high and low water, they should, when in harbours and rivers, be called respectively the "ingoing" and "outgoing" streams, but when offshore they should be named in accordance with the direction in which they are flowing, *e.g.* "north-going stream", "east-going stream".

In the course of time these streams may carve out channels in the sea bed and throw up banks and shoals between them. The water in such channels is known as the "tideway", and may be expected to flow seaward for about six hours, then slacken, then turn and flow for six hours in the reverse direction until it becomes slack water again, and so on. The period of slack water will not necessarily coincide exactly with the times of high and low water.

The tidal stream along a stretch of coast will usually flow parallel with the coastline, but where such a stream meets river currents it may be deflected in any direction.

Unlike a wind, a tidal stream is named by the direction in which it is *going*, so we speak of a "west-going stream", or a stream setting 270° , for example.

Clear indication of the set or direction of the stream is given by ships riding head on to it, or by buoys canting away from it (except the dan buoy which is so moored that its staff inclines up-stream or down-wind, whichever is the stronger), or by the ripple of water in the wake of a moored object such as a buoy (see Fig. 372). Inshore, indications are given by drifting flotsam and by the ripple in the wake of posts or piles. By noting such indications the seaman saves himself much time and labour in boatwork, and avoids possible damage to his craft when she is alongside.

The tidal stream runs faster where the water is deeper or the channel narrower. At the mouth of a river or in the waters of an estuary the stream

usually runs most strongly during the third and fourth hours of any tide, and these "half-tide" streams reach their maximum rate at the period of springs.



Fig. 372. Some signs which show the direction in which a tidal stream is setting

Extra care should be taken when proceeding along coasts where the tidal range is considerable, especially when passing bays where there are generally indraughts although the general run of the tidal stream may be parallel with the shore. The turn of the tidal stream off-shore seldom coincides with the times of high and low water inshore, and the difference off deep indentations in the coast may amount to as much as three hours. Along straight stretches of coast the tidal stream off-shore will turn shortly after high and low water.

Harbour Tidal Streams.—When a river current meets tidal water the outgoing stream will naturally run longer and stronger than the ingoing stream, especially if the river is swollen after recent rains; such an exceptionally strong outgoing stream is called a freshet. When backed by a river current the outgoing stream can run very strongly indeed at half-ebb, particularly at the period of spring tides.

Weather-going Stream.—Whenever a strong stream is flowing against the wind an uncomfortably short steep sea is raised; this sea usually abates noticeably at the turn of the tide. Such conditions call for extra care in handling boats, and in tending boats secured alongside a ship in the tideway.

Tidal Rivers.—In tidal rivers the current is usually stronger in mid-stream on straight stretches, but on bends the current and channel usually hug the outer shore of the bend. Promontories, groins, piers, and all similar projections of the banks into a river, usually cause shoals to form on either side of them unless the bank is steep, the river bed rocky, or the river sluggish. *The terms right and left bank of a river assume the observer to be facing its mouth from a position up-river.*

River Eddies.—At certain stages of the tide it may be found that part of the stream is deflected by some point of land in such a way that it forms eddies close inshore. For a time the eddies may combine to form a stream flowing in the opposite direction to that of the main stream. Use can often be made of these contrary eddies to assist a boat in making headway against a strong current or tidal stream.

Turbulence.—Turbulence may be defined as the disturbance of the even flow of a current or tidal stream. It may be caused by an obstruction such as a promontory, island, pier or jetty; or by the meeting of opposing currents or streams, or by a sudden change in the depth of water such as occurs with the formation of pot-holes in the sea-bed. Under the heading of turbulence can be classed such disturbances known as "eddies" "ripples" "overfalls" and "races".

Turbulence of one sort or another usually occurs on the lee side of an obstruction (*i.e.* the side opposite to that against which the stream or current flows), and it usually takes the form of steep confused seas which may constitute a danger to boats or small vessels. Turbulences are marked on charts and it is wisest for small vessels to give them as wide a berth as possible.

Making good a Course in a Tidal Stream or Current.—It is important to realise that in a tideway the speed and course of a vessel through the water may differ considerably from her speed and course over the ground. This particularly applies to pulling boats and other low-powered craft.

If a boat pulling up harbour to a ship in mid-stream has a strong tidal stream or current against her she will save time and labour by keeping inshore, where the stream or current is usually weaker, until abreast the mark aimed at, and then making across to the mark—even though the actual distance covered will have been greater. At certain stages of the tide she may find a contrary eddy close inshore, which will appreciably help her against the main stream.

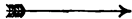
Sources of Information on Tidal Streams and Currents

Information on tidal streams can be found in the appropriate *Atlas of Tides and Tidal Streams*, when one is published for the area in question, and in the appropriate volume of the *Admiralty Sailing Directions*.

Information on currents is given in the *Current Atlas of the World*, and also in the appropriate *Admiralty Sailing Directions*.

Information on both tidal streams and currents is also given on most charts, as explained below.

Indication of Tidal Streams and Currents on Admiralty Charts

The existence of a current is indicated on Admiralty charts by a double feathered arrow, thus .

The existence of tidal streams is usually indicated only on the larger scale Admiralty charts of coasts and harbours.

Different forms of arrow are used for this purpose, as follows :—

- | | |
|---|---|
|  | indicating a flood stream ; |
|  | indicating an ebb stream ; |
|  | (dots on a flood stream arrow) the number of dots indicating the interval in hours after low water at the standard port ; |
|  | (dots on an ebb stream arrow) the number of dots indicating the interval in hours after high water at the standard port. |

A lozenge enclosing a letter or a figure, *e.g.* , refers to a table of tidal streams given on some convenient portion of the chart. These tables indicate the direction and rate of the tidal streams and the periods of slack water, in the vicinity of the lozenge, relative to the periods of springs and neaps and the times of high and low water at the local Standard Port.

How to Forecast a Tidal Stream from Information on a Chart

Example.—"What is the direction and rate of the tidal stream in the Shipway Channel off Harwich at 0900 B.S.T. on 14th June, 1950?"

On Admiralty chart No. 2052, *England—East Coast, The Naze to Orfordness*, in the vicinity of the Shipway is a lozenge enclosing the letter B; this refers to "Position B" in the table of tidal streams on the left-hand side of the chart, reproduced in Fig. 373.

Tidal Streams

		Position A			Position B			Position C			
		Lat. 51°50'N Long. 1°29'4"E			Lat. 51°58'N Long. 1°34'1"E			Lat. 51°59'6"N Long. 1°29'4"E			
Hour	Direction	Rate		Hour	Direction	Rate		Hour	Direction	Rate	
		Sp.	Np.			Sp.	Np.			Sp.	Np.
Before HW Harwich	6	33°	0.2 km.	0.1 km.	215°	0.4 km.	0.3 km.	208°	0.6 km.	0.4 km.	
	5	22°	1.3	0.8	210°	1.4	0.9	213°	1.4	0.9	
	4	25°	2.0	1.3	212°	1.0	1.2	214°	1.7	1.1	
	3	25°	2.1	1.4	214°	1.8	1.2	214°	1.6	1.0	
	2	19°	1.7	1.1	220°	1.5	1.0	217°	1.3	0.8	
	1	230°	1.1	0.7	223°	0.9	0.6	225°	0.6	0.4	
After HW Harwich	0	273°	0.4	0.3	18°	0.2	0.1	26°	0.5	0.3	
	1	26°	0.9	0.6	33°	1.1	0.7	34°	1.6	1.0	
	2	35°	1.8	1.2	36°	2.2	1.5	34°	1.9	1.2	
	3	38°	2.1	1.4	35°	1.9	1.3	33°	1.6	1.0	
	4	41°	2.0	1.3	36°	1.4	0.9	35°	1.2	0.7	
	5	43°	1.2	0.8	36°	0.8	0.5	41°	0.6	0.4	
6	61°	0.4	0.2	Slack			45°	0.1	0.0		

52°

Fig. 373. Table of tidal streams from Chart No. 2052

These tables show the Standard port (in this case Harwich), and the direction and rate of the tidal stream at springs and neaps for six hours before and after high water at Harwich.

Now, 0900 B.S.T. = 0800 G.M.T., and from the *Admiralty Tide Tables*, Vol. A, Part I we find that:—

H.W. at Harwich on June 14th = 1100 G.M.T.,
therefore the interval required = 3 hours before H.W.

Entering the table under "Position B" on the chart with this interval, it is found that:—

the direction of the stream = 214°;
the rate of the stream = 1.8 kts. for springs, and 1.2 kts. for neaps.

To calculate the rate of the stream for that hour the range of that particular tide must be divided by the spring or the neap range, and the result must be multiplied by the spring or neap rate shown against the hourly interval from high water.

From an examination of the heights of the tides at Harwich during June, it is seen that springs occur about June 17th and neaps about June 9th. June 14th is nearer springs than neaps, so the data for springs must be taken.

Place	Height above datum of soundings				Datum to which Soundings are reduced
	High Water		Low Water		
	Mean Sp	Mean Np	Mean Sp	Mean Np	
Orfordness	8.1 feet	7.0 feet	0.3 feet	1.3 feet	22 ft below the top of the step at the gate of Orfordness Lighthouse for Orfordness and Orford Haven Bar
Orford Haven Bar	7.9	6.8	-	-	
Woodbridge Haven	10.6	9.1	-	-	6.2 ft at Woodbridge Haven and 6.59 ft at Harwich below Ordnance Datum (Newlyn)
Harwich	12.6	10.5	1.1	2.9	

Fig. 374. Table of tidal information from Chart No. 2052

Just above the table of tidal streams on the chart is a table of "Tidal Information and Chart Datum" (reproduced in Fig. 374), giving the rise of mean springs and neaps at various places, including Harwich.

From the *Admiralty Tide Tables*, we find that :—

the height of H.W. at Harwich
 at 1100 on June 14th = 11.8 feet ;
 the height of the preceding L.W. = 2.1 feet ;
 therefore the range of tide = 9.7 feet.

From the table of tidal information on the chart, we find that :—

the rise of M.H.W.S. at Harwich = 12.6 feet ;
 the rise of M.L.W.S. at Harwich = 1.1 feet ;
 therefore the spring range = 11.5 feet.

From the table of tidal streams on the chart, we find, under "Position B" that :—

the spring rate at three hours before H.W. = 1.8 knots ;

therefore the rate required = $\frac{9.7}{11.5} \times 1.8 = 1.5$ knots.

The answer is, therefore, that the direction and rate of the tidal stream in the vicinity of the Shipwash at 0900 B.S.T. on 14th June is :—

214°, 1.5 knots.

CHAPTER XXV

Introduction to Pilotage

NAVIGATION is the art of taking a ship safely, and as quickly and economically as possible, from one place to another, and it necessitates recording her progress on charts and frequently checking her position by one or more of the following methods :—

- (i) taking bearings and distances of the land or seamarks by visual means or by means of radar, and/or taking soundings to ascertain the depth of water ;
- (ii) taking observations of the Sun, Moon or stars (when no land is in sight) ;
- (iii) using radio navigational aids such as " Decca ", " Consol ", " Loran ", and " high (or medium) frequency direction finding ", by means of which the position of the ship can be obtained, by day or at night, or in low visibility, in areas where these aids are available.

Pilotage is that part of navigation which concerns the safe conduct of a ship in the vicinity of coasts, in narrow waters, and in the vicinity of dangers such as rocks and shoals. Broadly speaking, navigation in pilotage waters may be considered as coming under two headings :—

- (i) *Coastal Navigation*, which concerns that part of a sea passage in which the navigator has the land in sight on one side of his course, and the open sea on the other.
- (ii) *Channel Navigation*, which is required when a ship has to be navigated in narrow channels with dangers on both sides, and in rivers or harbours and their approaches, as usually occurs at the start and finish of a sea passage.

This chapter is intended to introduce the seaman to the art of pilotage, and to describe the simple and more usual methods by which a ship's position, course, and speed are estimated or checked when she is in pilotage waters.

CHARTWORK

Plotting a Position by Latitude and Longitude

When a point is described by its latitude and longitude its position is laid down on the chart by one of the following methods :—

- (i) Place one edge of the parallel ruler along a parallel of latitude and move the ruler until one edge passes through the latitude of the place as indicated at the side of the chart. With the dividers, measure the distance at the top or bottom of the chart

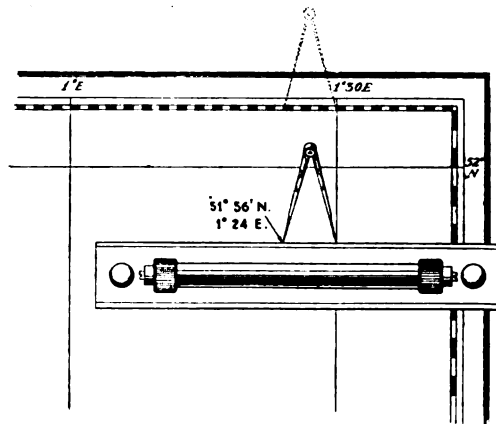


Fig. 375. Plotting a point described by latitude and longitude

from the nearest meridian to the required longitude, and lay this off from the same meridian along the parallel of latitude shown by the ruler. If more convenient the ruler can be placed to the longitude, and the latitude then be set off with the dividers.

- (ii) Alternatively, the latitude and the longitude may be drawn in by pencil, using the parallel ruler only.

Plotting a Position by Bearing and Distance

A position may be described by its bearing and distance from a known position such as a landmark or lighthouse; for example, "135 Eddystone 5" means that the position lies in a direction 135° from the Eddystone lighthouse and 5 miles distant from it. All such bearings are true bearings and the distances are in nautical miles.

Most charts have printed on them one or more compass roses from which a line of bearing can be drawn with the aid of a parallel ruler. Each rose has an inner and an outer circle of graduations; the graduations on the outer circle show true directions, and those on the inner circle show magnetic directions for the year in which the chart was published, the variation and its annual change being indicated on this circle.

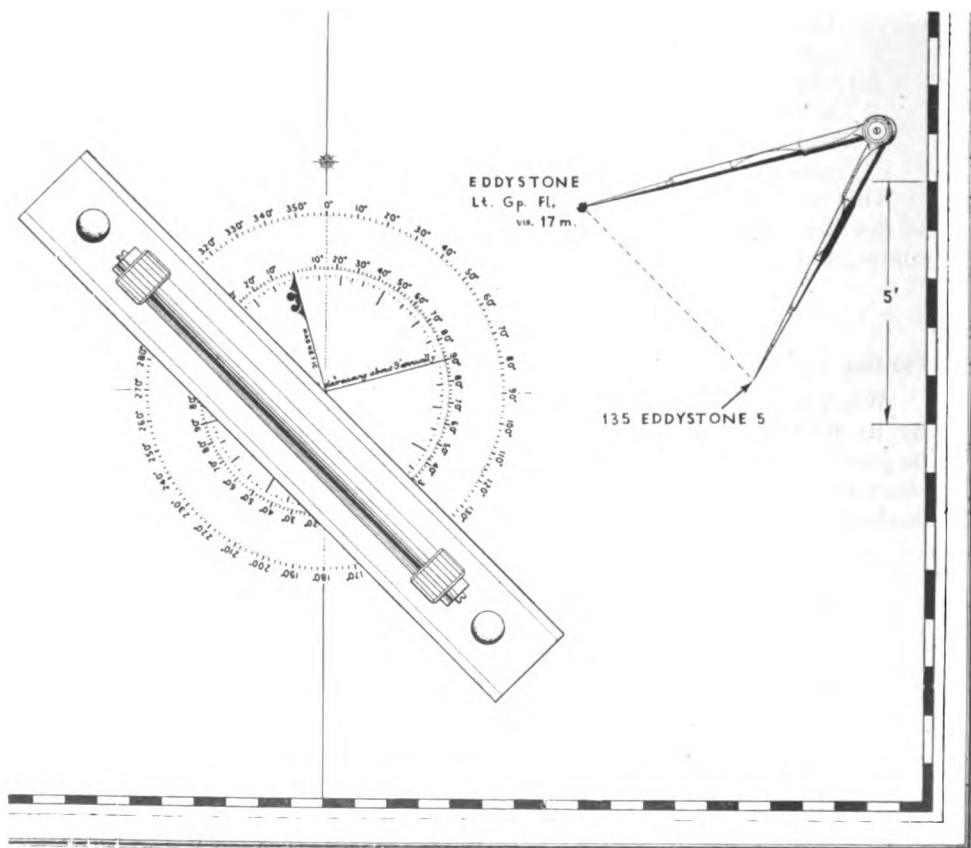


Fig. 376. Plotting a point described by bearing and distance

The distance scale is the scale of latitude at the side of the chart, one minute of latitude being equal to one nautical mile. It is important to remember that this scale on a chart alters with the latitude, and that the distance should therefore be measured off that portion of the latitude scale which is abreast the position which is to be recorded.

To record the position quoted above, first measure five miles from the latitude scale with a pair of dividers, then place the parallel ruler over the nearest compass rose on a bearing of 135° ; now move the ruler until one edge passes through the Eddystone lighthouse, and lay-off the distance with the dividers in the direction of 135° from the lighthouse.

Laying-off and Taking-off Courses and Bearings

Gyro-compass courses and bearings must be corrected for any gyro error before they are laid-off on a chart, and similarly, true courses and bearings taken off a chart must be corrected for any gyro error before they are applied to the gyro-compass.

Courses and bearings by magnetic compass should, before being laid-off on the chart, be converted to true courses and bearings by applying the deviation and the variation, the latter being corrected for the change of variation indicated on the chart. Similarly, a true course or bearing taken off a chart must be corrected for the variation and change of variation, and for the deviation, before it is applied to a magnetic compass. These conversions from true to compass, and *vice versa*, may be made by combining the three corrections and applying them as a single, combined, or total, compass error. *It should be borne in mind that the total compass error will change with an alteration of course by the amount of change in the deviation.*

The following example shows how this combined error is calculated.

Example.—Variation is $15^\circ 30' \text{ W}$ (1936) increasing about $7'$ annually. True course from chart is 154° . What is the compass error in 1950?

By comparison between the true and magnetic roses the compass course will be about 170° C , on which course the deviation is 4° E . (If there is a large deviation this must be allowed for when estimating the compass course.)

Variation for 1936 is	$15\frac{1}{2}^\circ \text{ W}$
Change of variation is $98'$ plus, say	$1\frac{1}{2}^\circ$
Variation for 1950 is therefore	17° W
Deviation for 170° C is	4° E
Compass error is therefore	13° W

While the ship is on a course 170° C all compass bearings may be converted to true bearings, and *vice versa*, by applying this compass error of 13° W .

When the ship alters course the compass error must be altered by the amount the deviation has been changed. For example, if the deviation on one course is 4° E , and on the next course it is 2° W , the total change will be 6° W , and this amount must be applied to the compass error for the original course to obtain the compass error for the new course.

The following examples show how a compass error is applied :—

Example 1.—The bearing of a lighthouse is 247° C by magnetic compass. What is the true bearing if the compass error for the course on which the ship is steering is 17° E ?

Brg. of Lt. Ho.	=	247° C
Comp. Err.	=	17° E (<i>compass least, add</i>)
True Brg. therefore	=	264°

Example 2.—The true course taken off a chart is 133° . What is the compass course if the compass error is 13° W ?

True Co.	=	133°
Comp. Err.	=	13° W. (<i>compass best, add</i>)
Comp. Co. therefore	=	146° C.

Recording a Ship's Position

The position of a ship may be recorded on a chart in one of the four following ways :—

- (i) As a position obtained by observation of the Sun, Moon or stars, which is known as an "observed position", and is recorded thus :—
 $\odot$ obs. 1100 (the figures indicate the time at which the observations were taken).
- (ii) As a position obtained by bearings and/or ranges of known landmarks or seamarks, which is known as a "fix", and is recorded thus :—
 $\odot$ fix 1100.
- (iii) As a position obtained by estimation of the probable track of the ship, taking into account any effects of wind, current, tidal stream, drift, or any other factor which may affect her movement over the ground, which is known as an "estimated position" and is recorded thus :—
 $\triangle$ E.P. 1100.
- (iv) As a position obtained by plotting the estimated speed made good by the ship through the water along the course steered, which is known as a "dead reckoning position" and is recorded as $+$ DR. 1100, or, if it is on a line already drawn on the chart, as $\overline{\text{DR. 1100}}$ $\overline{\text{DR. 1130}}$

By these methods of recording the navigator can tell at a glance by what means a charted position has been obtained and what degree of reliance he can place on its accuracy.

Transferring a Position from One Chart to Another

The scale of one chart may be different from that of another, and when a position is transferred from one chart to another it should therefore be laid-off by its bearing and distance from some object common to both charts and checked by its latitude and longitude.

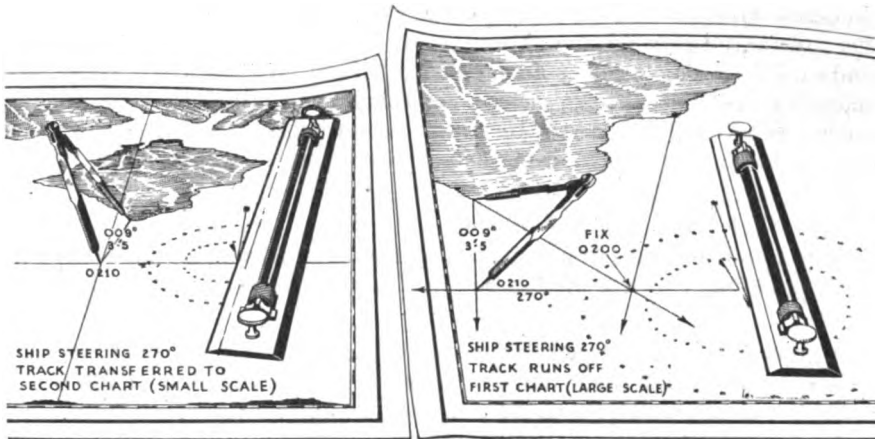


Fig. 377. Transferring a position from one chart to another

Plotting the Ship's Track

Plotting the ship's track on the chart is complicated by the effects of current or tidal stream and wind, so her course and speed through the water (which are obtained from the compass and the patent log or other method of speed recording) will by no means be the same as her course and speed over the ground (which the plotted track is required to show). To plot the ship's track on the chart it is necessary to know the course and speed made good over the ground.

The ship's track should therefore be plotted in two steps as follows :—

- (i) Starting from the last known position, plot the course steered through the water and the speed steamed along that course, thus arriving at the "dead reckoning" position.
- (ii) Plot in the correct direction from the dead reckoning position the combined effect of the current or tidal stream and wind. The position now arrived at is the estimated position.

The effects of current or tidal stream and wind must be considered before proceeding with the actual plotting on the chart.

Currents must not be confused with tidal streams. Information on currents is obtained from the ordinary Admiralty charts, from special Admiralty Current Charts, and from the Sailing Directions.

Information on tidal streams is to be found on Admiralty charts and in special tidal atlases. The navigator should always note down and remember the times of high and low water, and constantly revise his assessment of the set and rate of the streams according to the time and place, remembering that the slower the speed of his ship the greater will be the allowance necessary to make good his desired course.

The effect of wind can be estimated only by experience of the particular vessel's behaviour. It is only necessary to judge the amount the ship has been removed to one side or the other of her course, because the effect of the wind on the speed of the ship is allowed for in the speed made good through the water as shown by the log. Leeway, which depends on the draught of a ship

compared with her freeboard and on the extent to which her superstructures offer resistance to the wind, is often cancelled out by her tendency to "bore to windward"; particularly is this so with a light, shallow draft vessel in a quartering sea, but an experienced helmsman will ensure that the average course steered is that ordered, by taking care whenever the ship is forced to windward of her course, to swing her back an equivalent amount to leeward of it.

An entirely separate effect of wind is the drift of the surface water caused by prolonged high winds from a particular quarter. This drift may be expected to reach one knot with a wind of 50 knots after it has been blowing for about six hours.

A good rule for this estimation is that the surface drift is usually found to amount to about 1/50th of the wind's velocity. In temperate latitudes it is inclined at about 40 degrees to the direction towards which the wind is blowing, to the right in the northern hemisphere and to the left in the southern hemisphere.

The following example, illustrated in Fig. 378, is given to show how the effects of current or tidal stream and wind are allowed for when the track is plotted.

Suppose that at 0900 the ship is known to be in latitude $57^{\circ} 45' \text{ N.}$, longitude $1^{\circ} 40' \text{ W.}$, steering a course 290° and making good a speed of 10 knots through the water. From the tidal stream atlas (or from information given on the chart) it is found that at 0900 the tidal stream should be setting 260° at a rate of 2.5 knots. The wind is N.E., force 8.

FIRST STEP. *Plotting the course steered and the speed made good through the water.*—The starting point A (Fig. 378) may be a fix or an observed position. Place the parallel ruler on the nearest compass rose so that its edge passes through the centre of the rose and through 290° (the course being steered) on the outer circle of graduations, and for increased accuracy make sure that it also passes through 110° , the reciprocal of the course. With the parallel ruler transfer this direction so as to pass through the starting point A, and draw a line of sufficient length to show the whole run; this will be the ship's course. The patent log or revolution table will give the distance steamed through the water between 0900 and 1000. In this example the speed made good is 10 knots. Measure off 10 miles from the scale of latitude corresponding to the latitude of A, and lay it off from A along the course, thus obtaining the point B which is the "dead reckoning position" at 1000, and therefore marked thus: + D.R. 1000.

Notes :—

- (i) If a magnetic compass is used the compass course must be corrected for deviation and laid off on the inner circle of graduations, *i.e.* that for the magnetic compass rose, allowance being made for the alteration of variation since the year when the chart was printed.
- (ii) If the dead reckoning position has been obtained from a log reading, the effects on the ship's speed of a head or a following sea or wind will have been taken into account. If the position has been estimated from the revolution table these effects must be allowed for together with the state of the ship's bottom.

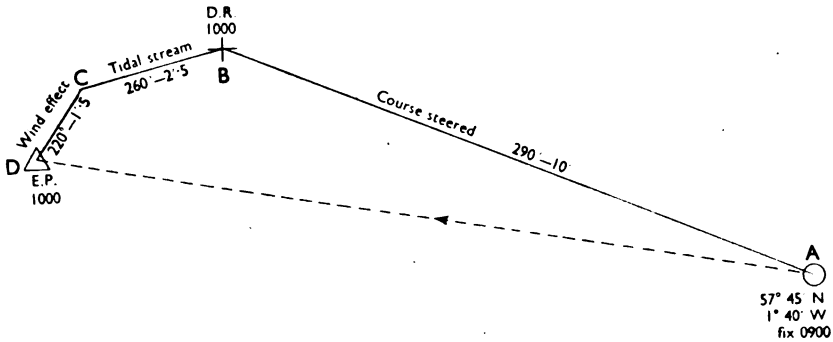


Fig. 378. Plotting the ship's track

SECOND STEP. *Plotting on, from the dead reckoning position, the effect of any current, tidal stream or wind (other than that already allowed for in the speed made good through the water).*—It is now necessary to consider the tidal stream, which is setting 260° at 2.5 knots, and the effect of the wind, which is N.E. force 8. It is estimated, either from experience or by calculation from the drift rule given above, that the effect of the wind will set the ship in a 220° direction at 1.5 knots.

From the 1000 D.R. position B lay off a line BC, 260° , 2.5 miles, to represent the amount the ship will be set by the tidal stream.

From C lay off a line CD, 220° , 1.5 miles, to represent the drift of the surface water carrying the ship with it.

We now have a scale diagram showing what happens during one hour's run. The point D is the "estimated position" at 1000, and is therefore marked thus; $\triangle$ E.P. 1000. The dotted line AD is the track which it is estimated the ship will make good over the ground.

Until a definite fix or reliable observed position is obtained, this estimated position should not be erased, even though subsequent checks, such as soundings, a single position line, or doubtful sights, may cast doubt upon its accuracy.

Shaping a Course allowing for a Tidal Stream

Example.—What course must a ship steer when steaming at 12 knots to make good a course 090° if it is estimated that the tidal stream is setting 040° at 3 knots?

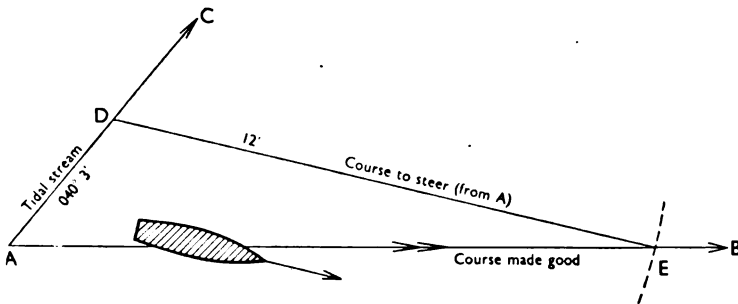


Fig. 379. Shaping a course allowing for a tidal stream

Lay off the course to be made good, 090° (AB in Fig. 379). From A lay off the direction of the tidal stream, 040° (AC). Along AC mark off AD equal to the distance the tidal stream sets in any convenient interval of time on a chosen scale; in this example a one-hour interval has been allowed, so that AD will be three miles.

With centre D, and radius equal to the distance the ship steams in the same interval of one hour (12 miles), describe an arc to cut AB at E. Then join DE, which will be the course to steer.

This course is actually steered from A, and AE is the *distance made good* in an 090° direction in one hour and is usually marked with two arrow-heads.

Reaching a Position at a Definite Time allowing for a Tidal Stream

Example.—What course must a ship steer, and at what speed must she steam, to proceed from a position A to an anchorage B in $1\frac{1}{2}$ hours, allowing for a tidal stream setting 150° at 3 knots?

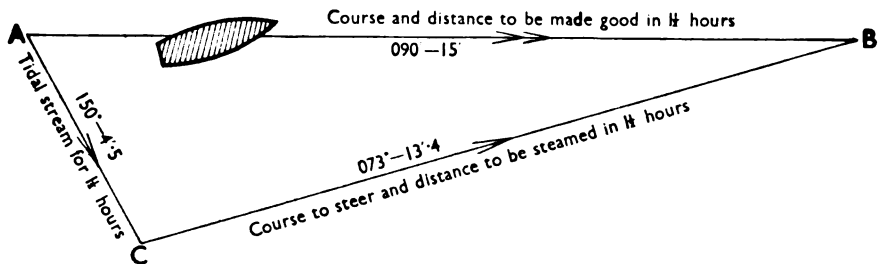


Fig. 380. Estimating course and speed to reach a position at a definite time, allowing for a tidal stream

Join AB as shown in Fig. 380. This determines the course and distance to be made good in $1\frac{1}{2}$ hours, *i.e.* 090° , 15 miles.

From A lay off the direction of the tidal stream, 150° , and the distance it sets in $1\frac{1}{2}$ hours, AC, which = $4\frac{1}{2}$ miles. Join CB. Then CB represents the course to steer, 073° , and the distance the ship must steam in $1\frac{1}{2}$ hours, 13.4 miles. The speed of the ship should therefore be 8.9 knots.

Position Lines

A position line when drawn on a chart is a line, straight or curved, on some part of which the ship is known to be. Position lines may be obtained by observation of the Sun, Moon, or stars with a sextant, or by compass bearings of landmarks or seamarks whose position is accurately known, or by a line of soundings.

If two or three position lines lying in different directions are obtained simultaneously, the position of the ship at the time the observations were taken should be at the point where the lines intersect, which point is known as a "fix". If possible, position lines should intersect at an angle of not less than 30° , otherwise errors in the observations will be unduly magnified and the actual point of their intersection may be difficult to distinguish.

A position can be found by using two position lines obtained at different times, and allowing for the ship's run and the effects of tidal stream, current and wind, during the interval; it is then known as a "running fix".

It is usual to mark a position line drawn on a chart with a single arrowhead to distinguish it from other lines. When a position line is transferred to another position it is marked with two arrowheads.

There are different ways of obtaining position lines, the use of which depends upon the weather and the navigating equipment available. Extensive coastal passages can be made in small craft with the aid of charts, compass, watch, lead line, tide tables and some means of estimating the speed of the vessel through the water, and with this equipment it is possible to obtain position lines by :—

- (i) a compass bearing ;
- (ii) a transit ;
- (iii) a horizon range of a powerful shore light ;
- (iv) soundings ;
- (v) echoes of the siren.

The navigator of a big ship who has the additional aids of sextant, patent logs, sounding machines, echo sounding gear, radar, radio aids and W/T, can obtain position lines by a much wider range of methods. More essential than elaborate apparatus, however, are accuracy, alertness, and a dislike of taking anything for granted. Pilotage involves only the simplest calculations, and disaster is often brought about by very simple mistakes. In this chapter only those methods which are available in small craft are dealt with.

An example of the use of position lines to identify a particular spot without the aid of compass or chart is shown in Fig. 381.

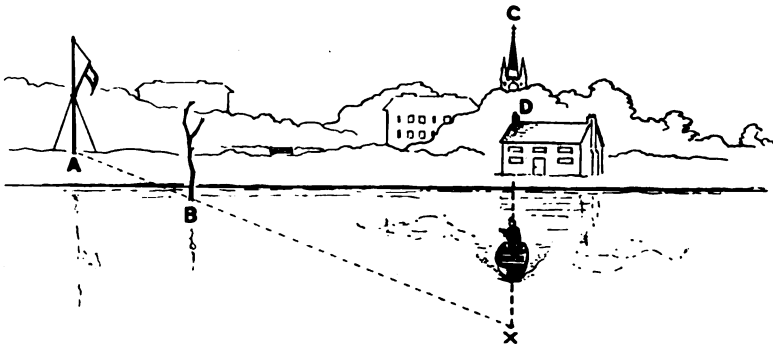


Fig. 381. Simple example of use of position lines

A fisherman has to abandon an anchor or some fishing gear at the position X. Before leaving this position he observes that objects B and D are in line with objects A and C respectively ; he can therefore return later to the same spot to recover the gear by steering a course which keeps D and C in line until he sees B come into line with A.

Transits

If an observer sees two objects in line, as in the above example, he must be situated somewhere on the line which joins them. The objects are then said to be "in transit", and they give an excellent position line provided that the distance between the observer and the nearer object does not exceed three times the distance between the objects in transit.

CHECKING DEVIATION AND COMPASS ERROR BY TRANSITS

If both objects are marked on the chart a position line can be drawn through them, and the bearing can then be found from the nearest compass rose. If a compass bearing is now taken of the objects in transit and compared with the magnetic bearing found from the chart, the deviation of the compass for that particular direction of the ship's head can easily be found as it will be the difference between those two bearings. In a ship fitted with a gyro compass, any error it may have can be found by comparing the gyro-compass bearing with the true bearings on the compass rose.

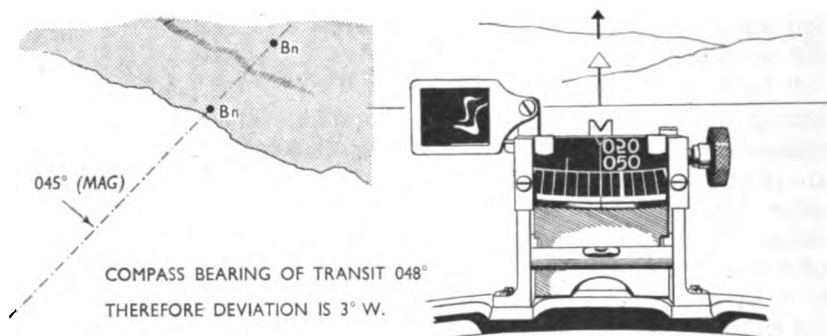


Fig. 382. Checking deviation of magnetic compass by a transit

Never miss an opportunity of checking the deviation of the compass by transits, particularly in small craft where large unknown compass errors may exist.

Example 1 (Fig. 382) :—

From chart, beacons in line bear 045° M (Magnetic)
 From ship, " " " " 048° C (by Mag. compass)

$$\text{Deviation} = 3^{\circ} \text{ W}$$

Example 2 :—

From chart, beacons in line bear 035° (True)
 From ship, " " " " 032° (by gyro-compass)

$$\text{Gyro error} = 3^{\circ} \text{ (low*)}$$

LEADING MARKS (Figs. 383 and 385)

Many harbour plans show two marks which, when kept in transit, lead the ship in the best channel. Such marks are called leading marks and are shown on a chart by a line drawn through them called a "leading line".

When the marks are in transit take a compass bearing and compare it with that given on the chart. This ensures that the objects seen in transit are the correct objects, and it also checks the error of the compass.

* The error of the gyro is expressed in degrees "high" or "low", depending on whether the compass is reading "high" or "low" on the true direction.

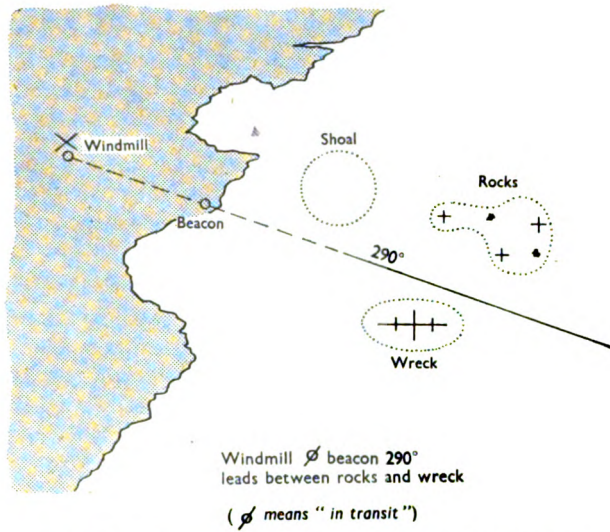


Fig. 383. Examples of leading marks and a leading line

CLEARING MARKS (Figs. 384 and 385)

When a hidden danger lies in the approach to an anchorage or harbour it will often be found that there is printed on the chart a straight line, called a

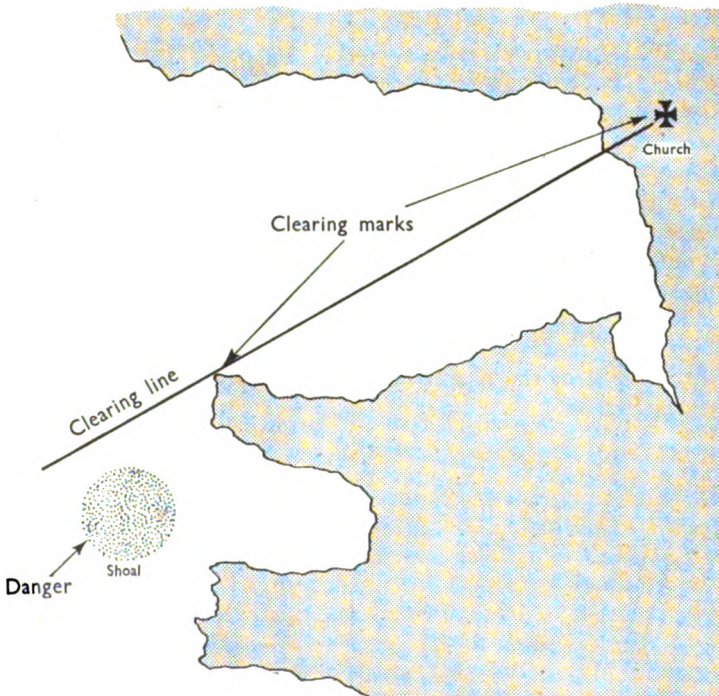
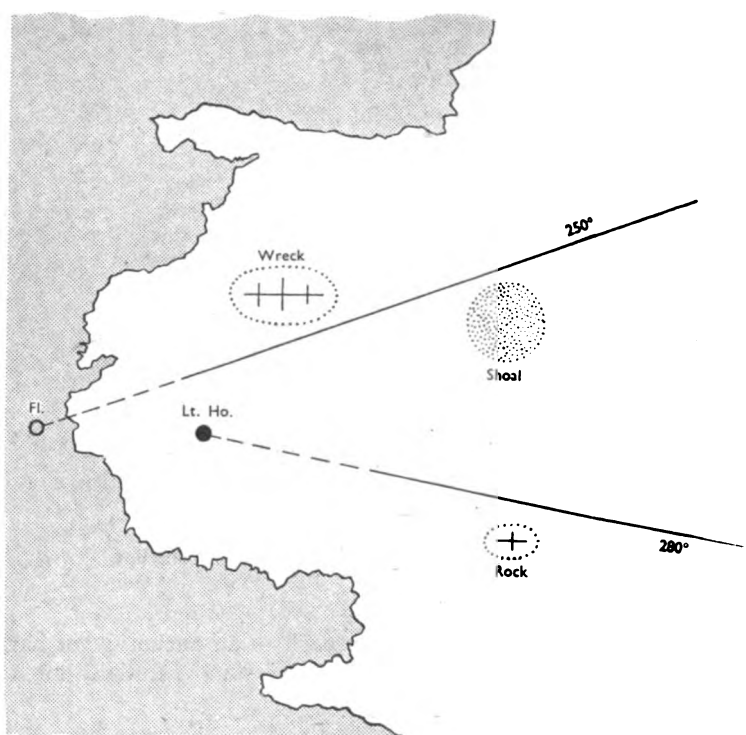


Fig. 384. Examples of clearing marks and a clearing line



Flagstaff 250° between shoal and wreck. Lighthouse 280° clears rock.

Fig. 385. Examples of a leading line and a clearing line

"clearing line", which runs clear of the danger and leads through two shore objects in transit called "clearing marks". When navigating near a danger take care not to go inside the transit line of the clearing marks. So long as the ship is outside this line, that is so long as the marks are kept "open", she is safe from this danger.

The expression "on with" means in line with, or in transit with. The expression "open of" means that the further object of the two should be visible to the right, or left, of the nearer object when the ship is approaching on a safe course (see Fig. 386).

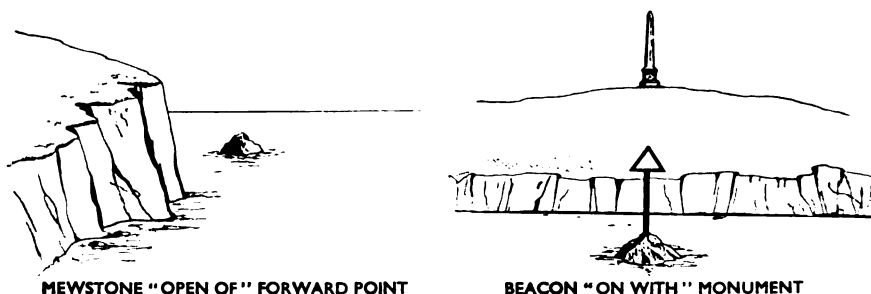


Fig. 386. Examples of the terms "open of" and "on with"

Position Lines and Fixes

The estimated position, as we have seen, is the position found from the course steered and the estimated speed through the water, corrected for any distance the ship has been moved by the tidal stream, current, wind and sea.

This position is liable to error, in which case all subsequent plotting of the track will be affected. It is therefore always necessary for the navigator to fix the ship's position as often as possible by observations which provide definite position lines. Any two such lines will give a fix, which a third position line will definitely confirm.

Before thus fixing the ship's position, identify all the objects you are going to use, and make certain that they are marked on the chart. It is no use taking the bearing of one conspicuous object and then having to look about to select the others. When taking cross bearings, first note the names of the objects to be observed and write them down. After this the bearings should be taken as quickly as possible, and the time and log reading should be noted immediately after taking the last bearing. The most favourable circumstances are when the first object observed is nearly ahead and the second nearly abeam; the bearing of the latter will change rapidly, especially if it is near the ship, and unless the bearings are taken almost simultaneously it will be impossible to get a satisfactory cut.

When using a magnetic compass remember that the deviation which must be used to correct the bearings is the *deviation for the direction of the ship's head when the observations were taken*.

SELECTING OBJECTS FOR A FIX

When a ship's position is fixed by three bearings the objects selected should, if possible, lie so that their bearings differ by about 60 degrees; the position lines will then make a good cut. If it is only possible to fix by two bearings, the objects selected should lie so that their bearings intersect as nearly as possible at right angles, as then the effect of any small error in taking the observations and laying them off on the chart is reduced to a minimum.

Always select objects near the ship in preference to distant objects, but a position line obtained from a bearing of a buoy, or of any other object liable to move from its charted position, should not be relied upon.

FIXING BY CROSS BEARINGS

When accurate lines of bearing of two different objects are obtained simultaneously the ship must lie at the point where those two lines intersect.

Suppose that at 1015, from an observer on board a ship, a lighthouse bore 040° and a church bore 125° , as shown in Fig. 387. If these two lines are drawn on the chart, the point of their intersection should be the ship's position at 1015. As, however, slight errors may arise in taking the bearings, and there may also be slight errors in the charted position of the objects, a third bearing, called a check bearing, should be taken. If all three bearings and the chart were accurate this bearing should pass through the point of intersection of the other two. In practice, however, owing to such errors it will be found that the three bearings, when plotted, form a small triangle known as a "cocked hat" (see Fig. 387), in which the check bearing is that of the beacon bearing 075° .

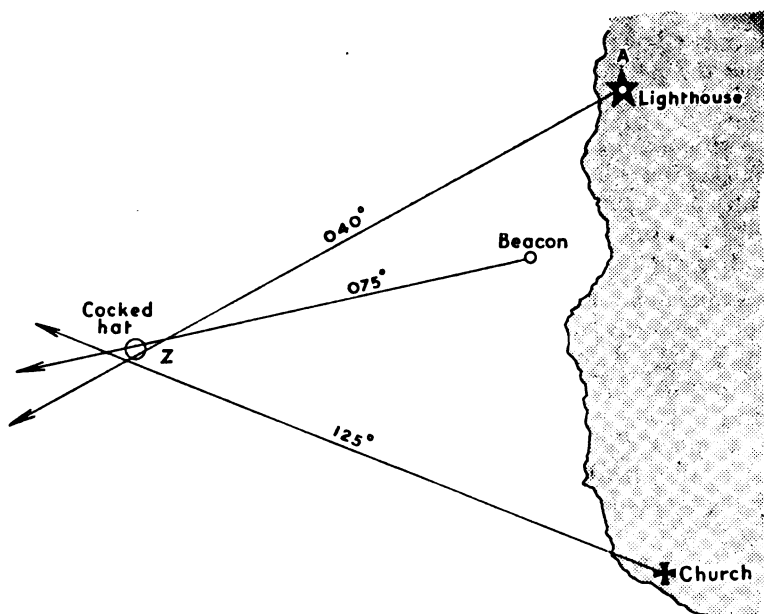


Fig. 387. Fixing by cross bearings

If the cocked hat is reasonably small the position of the ship is usually taken as lying at its centre. If the cocked hat is large, however, the bearings should be taken and plotted again to ensure that the objects have been properly identified and that there was no error in correcting the bearing. Then, if a large cocked hat still remains, the position of the ship should be taken as lying at the corner of the triangle which will place her nearest to danger, thus ensuring that subsequent alterations of course for rounding marks, etc., will have a probable safety margin.

As the cocked hat may also be caused by unknown deviation or gyro error, every opportunity should be taken to check the deviation or error of the compass. The opportunity for a check on at least one direction of the ship's head arises whenever two charted objects are passed in transit.

Example of a Bad Fix by Cross Bearings.—If the ship is on the circumference of a circle passing through the three objects, the three lines of bearing will always meet at a point, even when there is a large unknown compass error. Any unknown compass error may therefore pass undetected and an incorrect position be recorded (see Fig. 388).

Note that the conspicuous chimney should not have been used when there was a beacon on a nearly similar bearing *much closer* to the ship.

TO OBTAIN A RUNNING FIX BY TRANSFERRED POSITION LINE

It frequently happens that only one object can be observed, and so only one position line be obtained, at a given moment. This one line, however, can be used later to obtain a fix when a second line from another observation is obtained.

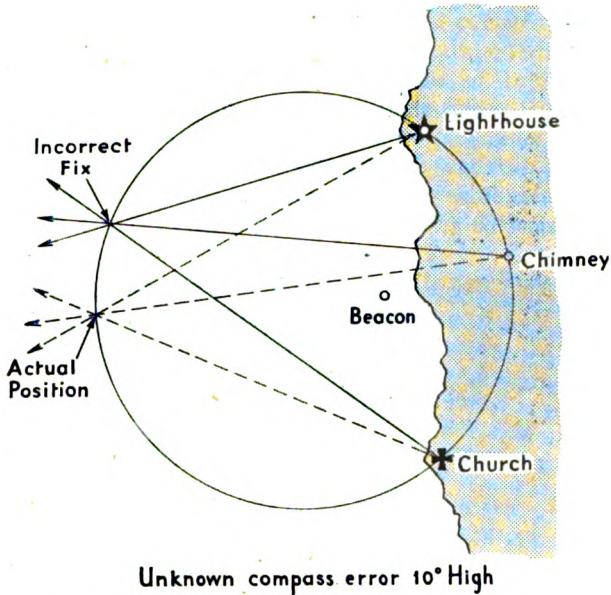


Fig. 388. Example of a bad fix by cross bearings

Example.—A ship is steering 090° at 8 knots. The tidal stream is estimated as setting 135° at 3 knots. At 1600 a lighthouse bore 034° . At 1630 the same light bore 318° . Find the position of the ship at 1630.

Draw a line ACE in an 034° direction to pass through the light, as in Fig. 389. This is the position line at 1600.

Now suppose that three lines are drawn, AB, CD and EF, each in a direction 090° and each 4 miles in length (the distance run in half an hour). Then if the ship is at A at 1600 she will be at B at 1630, provided that she is unaffected by wind, current, or tidal stream. Similarly, if she is at C or E at 1600 she will be at D or F at 1630.

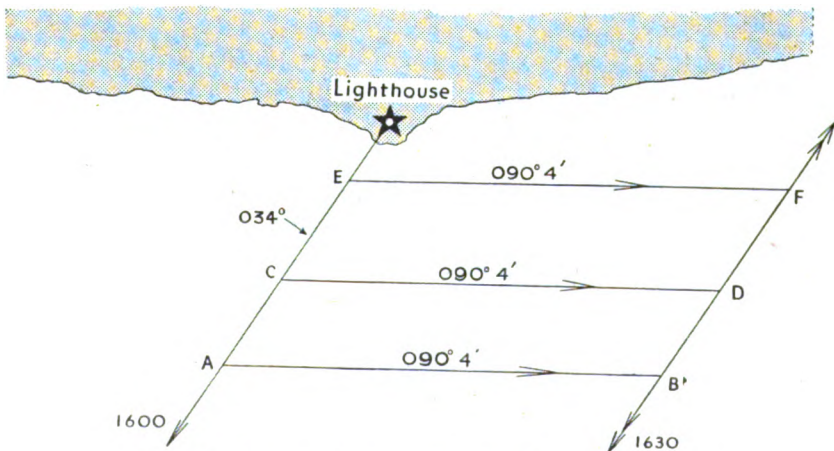


Fig. 389. Running fix by transferred position line, 1st step

Then, since ACE is the position line at 1600, BDF must be the position line at 1630; that is, the original position line has been transferred, and the new line is known as the "transferred position line". This is parallel with the original position line and is usually distinguished by two arrowheads at each end.

The ship is, however, set by the tidal stream, current, or wind during the run, and therefore the point through which to draw the transferred position line must be arrived at by two steps, as shown in Fig. 390.

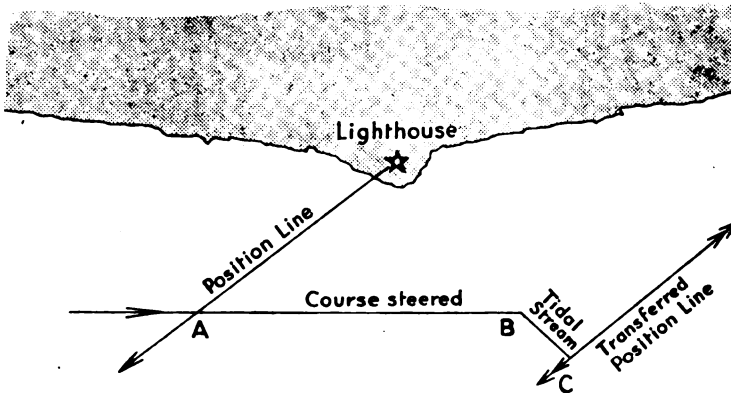


Fig. 390. Running fix by transferred position line, 2nd step

First lay off from any point on the original position line the course and distance steamed by the ship in the interval (AB). Then, from the end of this line, at B, lay off BC to represent the direction and distance the ship is estimated to have been set in the interval by tidal stream, current or wind. The position line should now be transferred to pass through C and be marked with two arrowheads at each end.

If the allowance made for the tidal stream, current, or wind experienced by the ship during this interval has been accurately estimated, the ship must be at some point on this transferred position line at 1630.

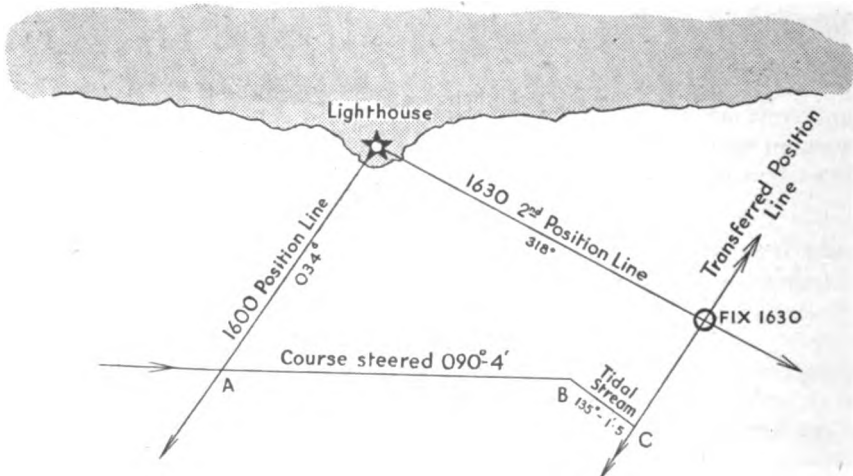


Fig. 391. Running fix by transferred position line, 3rd step

At 1630 the same light bore 318° , and this position line should now be drawn (as in Fig. 391). The point where the transferred position line drawn through C cuts this second position line is the ship's position at 1630, obtained by what is known as a "running fix".

It must be emphasised that the accuracy of a running fix depends entirely on the correct estimation of the course and speed made good between the bearings.

FIXING BY A BEARING AND SOUNDING

On approaching the land in places where the depth changes fairly rapidly, an approximate position can be found by observing a bearing of a charted landmark and at the same time obtaining soundings.

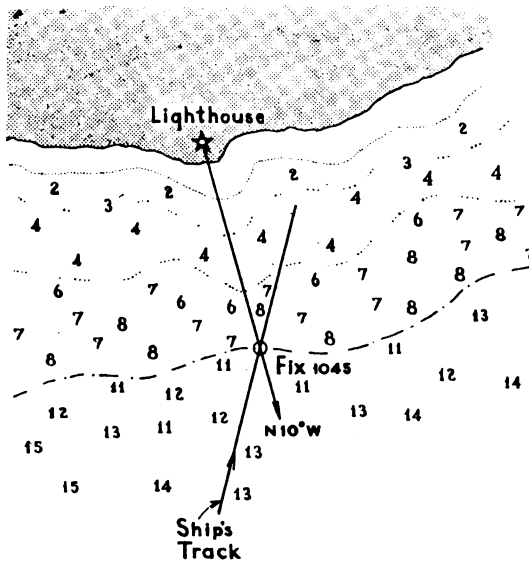


Fig. 392. Fixing by bearing and sounding

Remember, however :—

- (i) to make allowance for the height of the tide before comparing the soundings with the chart ;
- (ii) to select a bearing which crosses the fathom lines as nearly as possible at right angles ; and
- (iii) that the fix will not be reliable unless the fathom lines are very clearly defined.

Approximate Position by Bearing and Horizon Range of a Light (Fig. 393)

This method is most useful for finding the distance of a powerful light when it appears above the horizon or dips below it. The point at which a light thus appears or dips may be checked by the observer changing his height of eye.

The height of a light given on the charts and in the Light Lists is the height of the centre of the lantern above the level of mean high water springs.

The range of visibility of lights given on the charts and in the Light Lists is the distance at which they can first be sighted in clear weather by an approach-

ing observer when his eye is at a height of 15 feet above the sea, and when the level of the sea is that of M.H.W.S., *i.e.* when the height of the light above the level of the sea is at about its lowest. The light can therefore be seen earlier, and thus from a greater distance, if the tide is appreciably lower than M.H.W.S., or if the eye of the observer is more than 15 feet above the sea.

If a "Table of Distances" (showing the distance of the horizon for different heights of the eye) is available a fix can therefore be obtained (see page 25).

Example.—A shore light, whose height is given on the chart as 140 feet, is observed from the bridge to dip below the horizon (see Fig. 393). If the height of eye on the bridge is 40 feet, what is the distance of the light when the tide stands 10 feet below M.H.W.S. ?

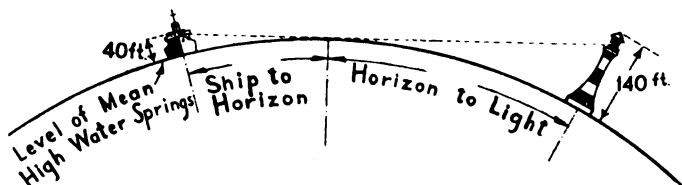


Fig. 393. Approximate position by bearing and horizon range of a light

The distance of the ship to the horizon and of the light to the horizon, can be found either from "Stevenson's Table" in the *Admiralty List of Lights*, or from "Table A" in *Lecky's Tables*. These distances added together give the distance of the ship from the light at M.H.W.S.

"Stevenson's Table" gives :—

the distance of the horizon from the light (for 140 feet)	= 13.57 miles ;
the distance of the horizon from a height of eye of 40 feet	= <u>7.26</u> miles ;
Therefore the distance of the light to the bridge at M.H.W.S.	= 20.83 miles.

But if the tide stands 10 feet below M.H.W.S., 10 feet must be added to the height of the light, so in this case :—

the distance of the horizon from the light will be that given for 150 feet	= 14.02 miles ;
the distance of the horizon from a height of eye of 40 feet	= <u>7.26</u> miles ;
therefore the distance of the light to the bridge	= 21.28 miles.

Distance by Siren Echo

If the echo of the siren can be heard reflected back from cliffs, the approximate distance of the cliffs can be calculated in cables by noting the interval of time in seconds between the actual blast on the siren and its echo, and then subtracting one-tenth from it ; for example, if 10 seconds elapse between the blast and its echo, the distance is nine cables.

REMARKS ON PILOTAGE

Preparation for a Passage

Before making a passage, careful preparation is required. This includes :—

- (i) collecting all available information regarding the navigational aids and dangers which may be encountered, and noting the times at which it is expected that they will be encountered or passed ;
- (ii) selecting a suitable track for the ship, and noting which part will be covered in daylight and which in darkness ;
- (iii) checking the accuracy of the compass and logs, and preparing sounding gear.

The publications shown below contain the information required.

Charts, which must be constantly kept up-to-date from the relevant corrections published in the *Admiralty Notices to Mariners*. The largest scale charts should always be used as they always give more complete information.

The Admiralty Tide Tables, which are published annually, and give the times and heights of high and low water at the principal ports.

The Admiralty Sailing Directions, which are usually called "Pilots", e.g. the "Channel Pilot" and the "North Sea Pilot", and give very detailed descriptions of the coasts with their harbours, ports, navigational aids, and dangers, and directions for passing coastal dangers and entering ports and harbours, thus amplifying the information indicated by the charts.

The Admiralty Lists of Lights, which give more complete particulars of shore lights, light vessels, and fog signals than are given on the charts.

Sailing Directions and Light Lists must be kept corrected by their latest supplement and all Admiralty Notices to Mariners affecting them.

In any case of discrepancy between these publications, the largest scale chart of the area should, if corrected to date, be taken as the correct authority.

Care and Use of Charts at Sea

The surface of the chart can best be preserved (and plotting will be much clearer) if a soft pencil and a soft rubber are used ; on no account should pen and ink or indelible pencil be used for plotting. The chart should always be folded along its proper creases and kept dry. In wet weather a towel placed along the front of the chart table to lean on, and removal of your cap before leaning over it, will save the chart from damage.

Take care of the parallel ruler, and of the points of dividers. A parallel ruler is less likely to slide or roll about if turned over on its back when not in use.

Chart Reading at Night.—The eyes take a long time to get accustomed to the dark after each exposure to white light. If at night one eye is kept shut while working on the chart until the chart table light can be switched off, the temporary blindness caused by the light will be lessened and night vision be much improved. As the result of the introduction of orange lighting, which greatly reduces this temporary blindness, violet ink is now used instead of red for chart corrections, etc.

Coasting

Lights.—Never pass a light without checking its period and characteristics.

Lightbuoys.—Do not rely on lightbuoys alone, because the light sometimes fails.

Buoys and seamarks.—Do not fix your position by buoys when other objects are visible close to the ship. Remember that the buoys marking a shoal are frequently changed as the shoal extends, and they may be moved occasionally by local authorities before there is time for the information to be embodied on the charts. On the other hand, after a notice concerning the movement of buoys has been promulgated and embodied on a chart, there may have been some unforeseen delay in putting the notice into effect.

Bays.—Remember that currents and tidal streams often follow the coastline and consequently set into bays and bights.

Fixing the Ship

(i) Fix frequently when possible. Jot down the bearings and times of each fix, together with the reading of the log, in your notebook.

Many fixes may eventually be unnecessary, but fog or rain squalls may suddenly reduce visibility without warning, and the last fix obtained then becomes of the greatest importance.

(ii) Always select objects close to the ship in preference to distant objects. It is preferable to fix at regular intervals and so get a constant check on the speed made good.

(iii) Always use the largest-scale chart.

(iv) Having fixed the ship's position on the chart, always write the time against it and project from it the course made good.

The position of the ship should always be marked on the chart at frequent intervals, by dead reckoning if no fix is possible.

Write the course on the middle of the line which represents it on the chart.

(v) Keep a careful and continuous reckoning on the chart, and in your notebook, throughout the time the ship is at sea.

(vi) Do not have two charts on the table at the same time, because confusion between the scales may arise.

(vii) When passing between islands use objects which are all on one hand or all on the other whenever possible; the two islands may have been separately surveyed.

(viii) In taking a bearing of a low point of land there may be an error if the shore is shelving and the tide is above chart datum. What may appear at low water as a long low point may disappear as the tide rises. This error is emphasised where there is a great tidal range.

(ix) When the only objects available for taking bearings are mountain summits, or distant or inconspicuous marks, your fix may be very inaccurate and should be treated with great caution, or even disregarded if there is no other reason for mistrusting your estimated position.

(x) Great care is necessary when transferring from one chart to another, because they may be drawn on different scales. Transfer your position from one chart to another by bearing and distance of a well charted point common to both charts, and then check for any major error by verifying that the latitude and longitude of your position are the same by each chart (see Fig. 377 on page 669).

Safe distance at which to pass dangers.—The general rule in coasting is to pass close enough to the shore to make certain of seeing and identifying all prominent landmarks such as lighthouses and beacons, and thus be able to obtain frequent fixes.

A course should be steered which will not converge with the coast, so that if fog or mist should suddenly obscure the landmarks the ship can continue on her course without running into danger.

It requires experience to decide at what distance the ship's track should pass clear of coastal dangers. Beware of the half-way position which is not close enough to the land to identify its features easily and yet not far enough out to ensure being well clear of all dangers.

When the track of a ship is laid off, the distances at which to pass dangers will have to be adjusted for :—

- (i) the prevailing weather and the tidal streams and currents likely to be experienced ;
- (ii) the nature of the coast and the dangers being approached ;
- (iii) the probable opportunities for fixing the ship's position, both by day and at night.

Sighting other Ships.—When altering course to conform with the rule of the road, *always* :—

- (i) alter the course in plenty of time ;
- (ii) alter course sufficiently to make your intention clear ;
- (iii) take care not to resume your original course until all risk of collision is past.

Do not assume that every vessel sighted steering a similar course must be bound for the same destination as your are, or that other vessels sighted are navigated with more skill than your own.

Fog and Thick Weather

Just before your ship enters fog or thick weather always note in the bridge notebook the approximate bearing, distance, and course of any ships in sight.

GENERAL PRECAUTIONS

On entering fog the precautions described below should always be taken.

- (i) *Reduce to a moderate speed.*—In fog, moderate speed is held by the judicial courts to be “ such a rate of speed as will enable a vessel, after discovering another vessel meeting her, to stop and reverse her engines in sufficient time to prevent any collision from taking place ”.
- (ii) *Close water-tight doors* in accordance with the ship's standing orders.
- (iii) *Station additional look-outs*, both on the forecastle and aloft. The smoke and topmasts of ships in the vicinity can often be seen from aloft above the fog.
- (iv) Stand by to take soundings.
- (v) If in the vicinity of land, have an anchor ready for letting go.
- (vi) Order silence on deck, and listen for fog signals and approaching shipping.
- (vii) Start your prescribed fog signal.
- (viii) Warn the engine-room.
- (ix) Review in your memory the characteristics of all fog signals which may be heard in the waters in which your ship is sailing.
- (x) If in company with a ship astern, stream your fog-buoy.

H.M.S. 'Nonsuch'														
Wednes day 2nd. of June.														
Time	Log (Rating type) Pilot	Distance Run		Mean Revs. per Minute	True Course	Gyro Compass Course	Standard Compass Course	Deviation	Variation	Wind		Weather and Visibility	Sea Height in feet	Swell Direction from Height in feet
		Miles	Fathoms							Direction (true)	Force (0-17)			
0100														
0200		3	6		155°	156°	5 MILE	1° W						
0200	5.7	5	102		036°	035°	N 35 E	3° E	41° W			72-3		
0400	18.3	9	6	110	—	—	—	—	—	E	2	C	1/2	NE 3 1019.6 63° 6' 65°
0300	30.3	12	0	140	—	—	—	—	—					
0400	42.2	11	9	140	—	—	—	—	—					
0700	54.2	12	0	140	—	—	—	—	—					
0800	66.2	11	0	140	018°	019°	N 20 E	2° E	—	SSE	4	0	1/2	NE 3 1017.2 66° 6' 66°
0900	78.3	12	1	140	—	—	—	—	—					
1000	90.3	10	0	160	329°	330°	N 26 1/2 W	1/2	—					
1100	102.2	11	9	160	—	—	—	—	—					
1200	102.6	0	4	Van.	—	—	—	—	—	S	4	d	—	— 1015.5 67° 44' 66°
Number on sick list		Distance run through the water		Zone time kept at noon		Leave Granted to Ships Company						Anchor Bearings		
6		102.6		-13		Pat Watch and 1st Pat Stand Watch 1330 to 2300 Chief and Petty Officers 1330 to 2300						MAGNISI Light 187° Tower 255° CASTARA Point 306°		
1300														
1400														
1500														
1600										SW	4	P	—	— 1014.3 67° 64' 67°
1700														

Fig. 394. Specimen page of the Ship's Log

FOG SIGNALS FROM SHIPPING

When hearing before the beam the fog signal of a vessel the position of which is not certain, if circumstances permit you should stop engines and then navigate with caution. Note in the log the exact time at which the engines are stopped.

Article 15 of the *International Regulations for Preventing Collisions at Sea*, lays down that "steam vessels shall sound at intervals of *not more* than two minutes . . ." their appropriate sound signals. Make your signals regularly, clearly, and deliberately in accordance with this article. If possible, time them so as not to coincide with the signals of another vessel, but having once started a signal on no account break off in the middle of it in order to listen to the other vessel's signal.

The sound signals prescribed in Article 15, which are intended to broadcast the presence of a ship, must not be confused with those in Article 28, which are made only to a ship *in sight* to tell her how you intend to direct your course in compliance with the *Steering and Sailing Rules*.

1945. From <i>Malta</i> <i>Marina Sirova</i> to <i>Sicily</i> <i>Port Augusta</i> , and <i>Port Augusta</i>					
REMARKS					Initials of the Officer of the Watch
0145 Port watch employed preparing for com. 0200 Received D.C. State II A.					
0210 Weighed and proceeded 0215 Set course 155°, speed 12 knots (corrected) to D.C. State III A.					
0222 Gyro compass error by transit 1° high. 0227 DELLIMAR light bore 022° S, 0235 ½ 014°					
0315 Encountered 17. Stopped engines, assumed D.C. State II A. 17.5 knots (corrected) closed up					
0320 Proceeded on course 036° speed 8 knots					
0340 Fog cleared, increased speed to 12 knots, 17.5 knots (corrected) all clear, corrected to D.C. State III A.					
0400					
0430 Sighted high land bearing 361°.					
0600 Hands employed cleaning ship.					
0710 Sighted CORRENTI Salomel bearing 330°					
0740 <i>ALL - CORRENTI Salomel 200° Cape Annam 200° 0755 Cape Annam 200° 11.5 knots (corrected) at port 25 knots</i>					
0800					
0850 <i>Fin. Cape Annam 225° Cape Annam 270° Mount S. 200 307°</i>					
0900 <i>Divisions and progress</i>					
0915 Commenced action stations 0945 Hands employed on general ship's duties					
0950 <i>Cape Annam 270° Cape Annam 270° 11.5 knots (corrected) at port 25 knots</i>					
1030 Hands performed ship for entering harbour					
1100 Stopped engines 1100 <i>Keen to sail, anchored anchor in 10 fathoms, wind to a shudd</i>					
1105 <i>11.5 knots (corrected) and French frigates "Ma. Paul" at anchor</i>					
1200					
Position	Latitude	Longitude	Depending on	Currents Experienced	
0800	36° 39' N	15° 19' E	Shore fin	NIL	0100 {Tide 18' 10" Apr 19' 5"
1200					Drainage 1100 {Tide 18' 9" Apr 19' 6"
2000					Refer to station of ship to find tide from 6 to 10 fms
1230 Lieutenant A.C. JONES joined from U.K.					
Hands make and mend clothes					
1315 Mr. L. SMITH (civilian) disembarked to shore, 1 S.B.M. discharged to "docking"					
1415 Shore lights with fresh provisions and caution stores moved alongside. Embarked provisions and stores.					
1510 Shore lights slipped and proceeded					
Left overboard one transducer. Pattern No. 1234					
1600 Question, read Warrant No. 5. 2nd Port Port Watch exercised "out hedge anchor"					

Fig. 394—cont.

FOG SIGNALS MARKING NAVIGATIONAL DANGERS

Do not rely on hearing a fog signal from a light-vessel, lighthouse, or buoys, because the direction of sound is often deflected by fog and there are often large areas into which the sound does not penetrate.

Bell Buoys and Whistle Buoys are also unreliable in calm weather, as their sound signals may be operated by the motion of the sea.

Pilotage in Narrow Waters

When rounding points of land, spits, shoals, buoys and light-vessels, allow plenty of room; cutting corners is dangerous. When passing a buoy it is easy to see which way the tidal stream is setting by observing the "wake" made by the buoy. Similarly, the direction in which a light-vessel is heading will, unless she is moored head and stern, indicate the direction of the tidal stream if the wind is not strong enough to swing her across it.

When rounding buoys and light-vessels to windward and against the stream, they should always be given a wide berth. A ship passing near any light-

vessel that has clear water on all sides of her should pass downstream of her, because under-estimation of the strength of the tidal stream may result in collision.

Always compare the name, shape, colour, and topmark of a buoy with that shown on the chart, to avoid the possibility of mistaking one buoy for another.

LOW-LYING LAND

When the land is too indistinct to fix the ship's position by bearings of shore objects, fix by bearings of beacons and light-vessels, if available, in preference to bearings of buoys.

Where the shore is distant and low-lying, as in the Thames Estuary for example, buoys may be the only guide. Before making a passage in such a locality, especially if the weather is likely to be thick, lay down on the chart all your required courses and make due allowance for the tidal stream that should be running *at the time when you should pass them*. Note in advance each course and the distance to be run on it, also the time it will take to steam from buoy to buoy, or beacon to beacon. Then check the time and courses as you proceed.

If after passing one buoy the calculated time of your arrival at a second buoy elapses but you have not sighted it, *proceed with the utmost caution and stand by to anchor*.

FOG IN A NARROW CHANNEL

In fog it will be necessary to lay your ship's course close to the starboard-hand buoys instead of in mid-channel, and to reduce speed; consequently your courses from buoy to buoy, adjusted for tidal stream, current or wind, must be worked out afresh and entered in the notebook.

Always carefully check the type of each buoy sighted. When departing from a buoy, work out accurately the time at which the ship should pass and sight the next buoy at her present course and speed. If at the end of that time the next buoy is not in sight, *stop the ship and, if possible, anchor*, because when the ship's course has been laid close to the buoys there is a very small margin of safety.

The Ship's Log

This should be written up at the time when each incident recorded actually occurs (see Fig. 394). Full instructions for writing up this log, also various meteorological tables, are given in the front of it. The following notes amplify these instructions.

- (i) The "distance run" should be the estimation of the distance the ship has run through the water in each hour, and it should take into account :—
 - (a) the revolutions ;
 - (b) the reading of the log ;
 - (c) the state of the ship's bottom ;
 - (d) any favourable or adverse wind or sea.
- (ii) With a mercurial barometer, the corrected reading should be logged. With an aneroid barometer, the actual reading should be corrected from the appropriate table in the ship's log, and the corrected reading be logged.

- (iii) The anchor bearings should be the bearings of shore marks from the position of the anchor. If, subsequently, anchor bearings are checked to ascertain whether the ship is dragging, allowance must be made for the amount of cable out and the direction in which it grows.

Specimen entries in the Ship's log for a short sea passage are given in Fig. 394.

CHAPTER XXVI

The Solar System, Time, and the Stars

THE EARTH AND THE SUN

The Earth's Orbit Around the Sun

THE Earth spins around its axis like a top, from west to east, and completes one revolution in the period of a day. As well as spinning around its own axis the earth travels round the Sun in an ellipse known as its "orbit", completing one circuit in the period of a year.

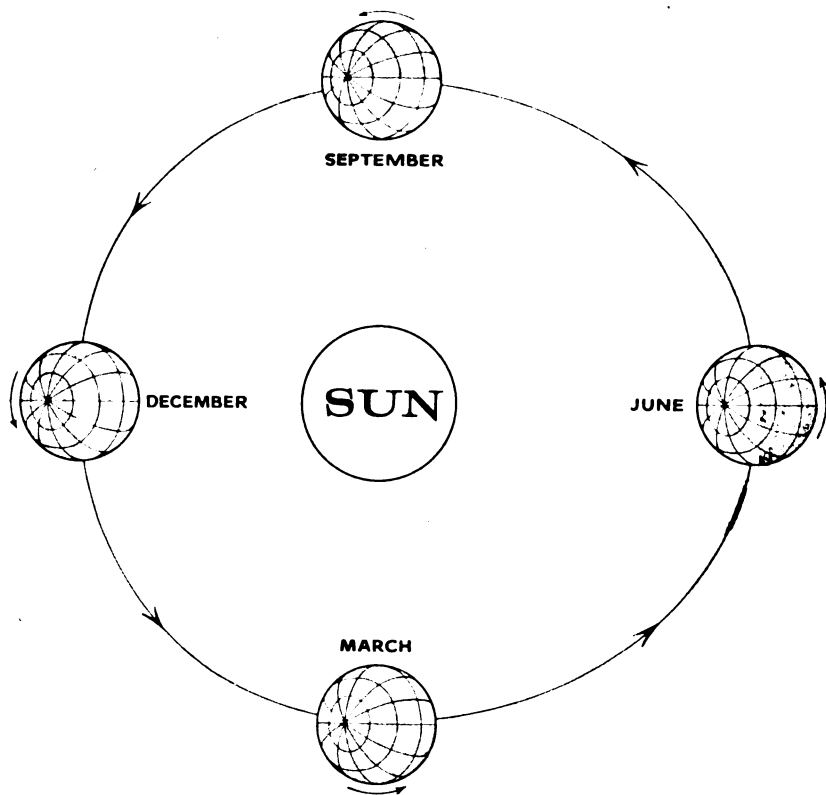


Fig. 395. Diagrammatic representation of the Earth's orbit round the Sun

A plan view of the Earth's orbit, as seen from a point above the North Pole, is shown diagrammatically in Fig. 395. From this view-point, the Earth appears to rotate on its axis in an anti-clockwise direction, and the direction of its orbit is also anti-clockwise. It should be noted that the Earth's orbit is not circular, but elliptical, and that the Sun is not in the centre of the ellipse. The Earth moves slightly faster along that half of its orbit which is nearer the Sun

than along the other half, the acceleration and deceleration being gradual. These peculiarities, combined with the Earth's rotation about its axis and its movement around the Sun, cause certain irregularities in the actual period of a day; a fact which is referred to later in this chapter in the section headed "Time".

The Sun is more than a hundred times the size of the Earth, but because of its great distance from the Earth (over 90 million miles) the rays of light and heat emanating from it can be taken as travelling parallel with each other in relation to the Earth. Because of its elliptical orbit the Earth is nearer the Sun in the northern winter than in the northern summer by about $1\frac{1}{2}$ million miles, but this has no appreciable effect on the temperature at the Earth's surface because the distance between the Earth and the Sun is so great. The difference in temperature between our winter and summer is caused by the inclination of the Earth's axis to the plane of its orbit.

The Seasons

The axis about which the Earth spins always points in the same direction in space throughout the Earth's yearly path around the Sun, and the angle at which it is inclined to the plane of this path or orbit is $66\frac{1}{2}$ degrees.

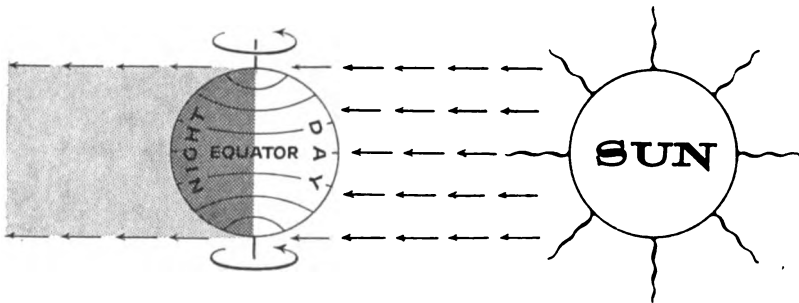


Fig. 396. Rays of the Sun relative to the Earth if the Earth's axis was at right angles to the plane of its orbit

If the Earth's axis were at right angles to the plane of its orbit (as depicted in Fig. 396) the periods of daylight and darkness would always be equal throughout the world, and no seasonal changes would be experienced in the northern and southern hemispheres, because every place on the Earth's surface would receive daily an equal amount of daylight and heat throughout the year. It would, however, still be colder at the poles than at the equator because in the vicinity of the poles the Sun's rays would strike the Earth's surface at an oblique angle, and so lose much of their heating effect.

The inclination of its axis, however, causes the Earth to present to the rays of the Sun a larger or smaller area of its northern and southern hemispheres at different times of the year. The change in the area thus presented by each hemisphere is of course gradual, and results in the gradual progression of the seasons from spring to summer, summer to autumn, and autumn to winter, as shown in diagrammatic form in Fig. 397.

When we speak of winter and summer we regard these seasons from the aspect of a person living north of the equator. At the time of our winter, or

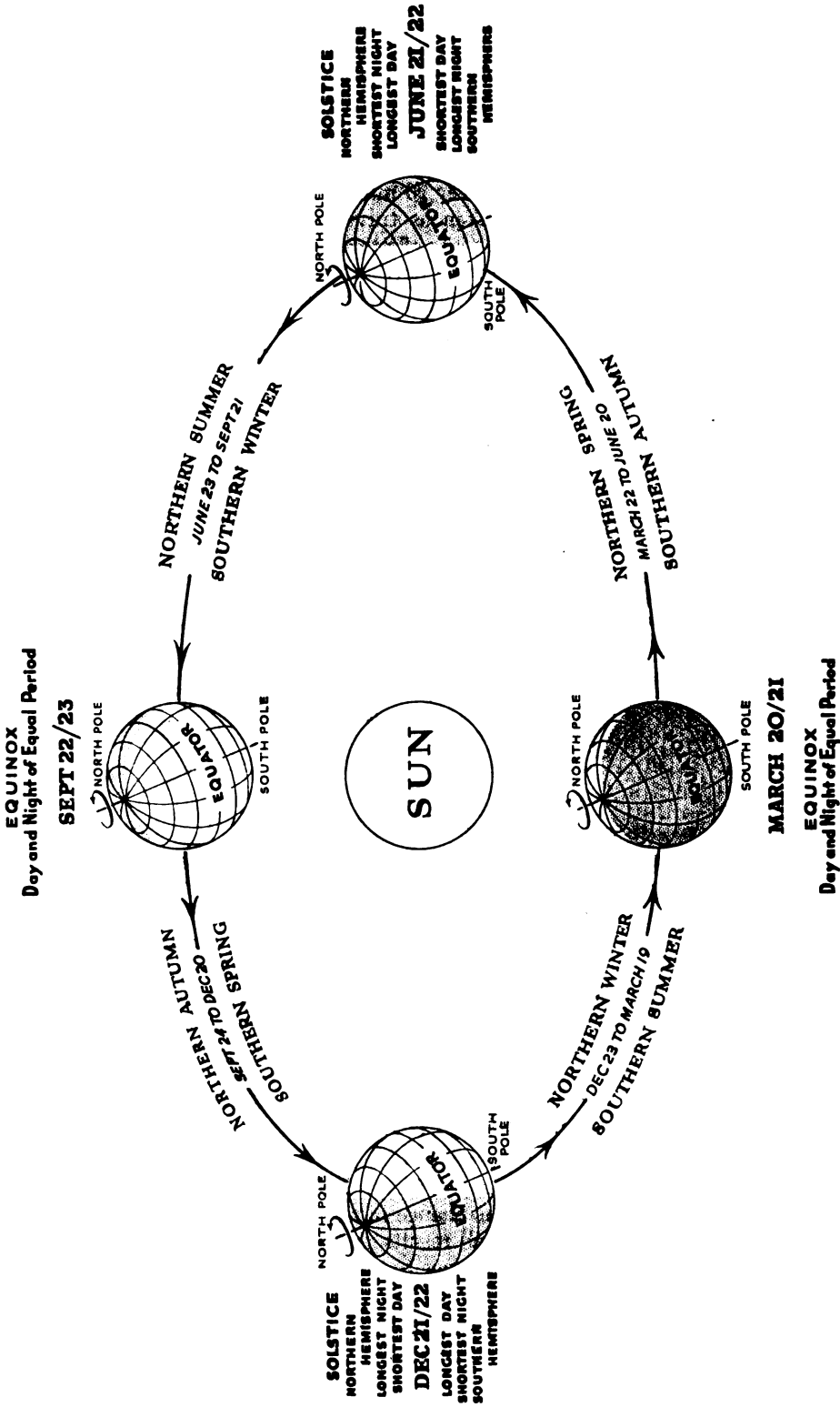


Fig. 397. Progression of the seasons

cold season, it is the summer or hot season for those who live in Australia. For this reason the seasons are better described as a northern winter or a southern spring if there is any likelihood of doubt.

From Fig. 397 it will be seen that the inclination of the Earth's axis to the Sun's rays is greatest on two occasions, each year, which are called the "solstices" and which occur on December 21st/22nd and June 21st/22nd. On the former occasion all places in the northern hemisphere experience their shortest day and longest night of the year, and all places in the southern hemisphere experience their longest day and shortest night. On the latter occasion this is reversed.

On March 20th/21st, and again on September 22nd/23rd, the Earth's axis is at right angles to the rays of the Sun, and therefore on these two occasions, which are called the "equinoxes", the periods of darkness and daylight are equal throughout the world.

The actual dates of the equinoxes and solstices vary slightly from year to year, but they will occur within these dates until 1980.

Between the equinoxes and the solstices the days and nights at any place become progressively shorter or longer, according to the hemisphere in which the place is situated and its latitude therein.

Climate

The Sun's rays travel parallel with each other and therefore strike the curved surface of the Earth at different angles. The angle at which the Sun's rays strike any particular place depends upon the latitude of that place and the inclination of the Earth to the Sun's rays at that period of the year. The heat of the Sun's rays has far greater effect where the rays strike directly than where they strike obliquely. In Fig. 398, which shows the inclination of the Earth to the rays of the Sun on June 21st and December 21st, it will be seen that at the polar regions the Sun's rays always strike obliquely, while at the equatorial regions they strike directly. Furthermore, the equatorial regions are under the rays of the Sun every day of the year, whereas the polar regions are in darkness or semi-darkness for half the year. For these reasons the polar regions are cold and the equatorial regions hot. The intermediate regions

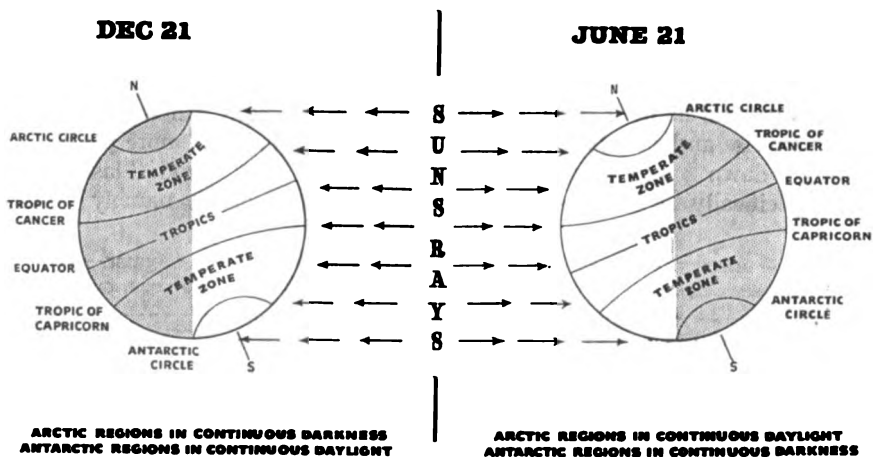


Fig. 398. Climatic zones, and relation between daylight and darkness

(except those in the heart of large masses of land) are most affected by the differences of temperature brought about by seasonal changes, but are seldom subjected to the extremes of heat and cold experienced respectively at the equator and at the poles.

For general purposes of describing its climate the Earth is divided into five regions, called respectively: the "tropics" (which lie either side of the equator), the "arctic" and "antarctic" (which lie respectively around the North and South Poles), and the intermediate "temperate zones".

The boundary between the tropics and the northern temperate zone is called the "tropic of Cancer", and that between the tropics and the southern temperate zone is called the "tropic of Capricorn"; these lie approximately along the parallels of latitude $23\frac{1}{2}$ degrees north and south respectively. The boundaries between the temperate zones and the polar regions are called the "arctic and antarctic circles", and lie approximately along the parallels of latitude $66\frac{1}{2}$ degrees north and south respectively.

Daylight and Latitude (Fig. 398)

The periods of daylight and darkness on any one day at any one place depend not only upon the season of the year, but also upon the latitude of the place. On the equator there is no appreciable difference between the periods of night and day, but in the latitude of London the difference may amount to to as much as about $9\frac{1}{2}$ hours, and within the polar regions there may be continuous darkness or daylight, according to the season of the year. The further a place is from the equator the greater therefore may be the difference between the hours of darkness and daylight, except when the equinoxes occur, when there is no difference.

Sunrise and Sunset

The time of sunrise at any place is taken as being the time at which the top of the Sun appears over the horizon, and the time of sunset is taken as being the time at which the top of the Sun disappears below the horizon. The actual times of sunrise and sunset on any date, and for latitudes between 73 degrees north and south, are published in the *Abridged Nautical Almanac*.

Twilight

This general name is given to the periods of half-light which occur shortly before sunrise and shortly after sunset, but these periods are more particularly named "dawn" and "dusk", respectively, or "first" and "last light". More specifically there are three categories of official twilight, namely "civil",

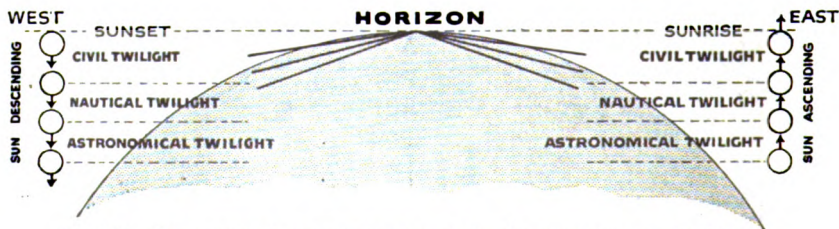


Fig.399. Diagrammatic representation of the three categories of twilight

CATEGORY	ANGLE OF DEPRESSION OF SUN BELOW THE HORIZON	REMARKS
Civil twilight	6°	Horizon can be distinguished. Light enough for work, and suitable for taking star sights.
Nautical twilight	12°	Artificial light necessary. General outline only of large objects visible. Horizon indistinguishable.
Astronomical twilight	18°	Beginning or end of complete darkness in so far as the sun is concerned.

“nautical” and “astronomical twilight”, which are illustrated in Fig. 399 and defined in the table above. The beginning or end of each is determined by the angle of depression of the Sun below the horizon.

The length of twilight depends upon the angle made with the horizon by the apparent path of the Sun, and this again depends upon the latitude of the observer and the date (see Fig. 400).

In the tropics the Sun rises and sets on a path which is within $23\frac{1}{2}$ degrees with the perpendicular throughout the year, and in these latitudes the duration of twilight is comparatively short, civil twilight lasting between 20 and 25 minutes, according to the date and actual latitude.

In latitudes outside the tropics, the angle made by the Sun's path with the horizon on rising and setting decreases as the latitude increases, and consequently the duration of twilight increases in proportion.

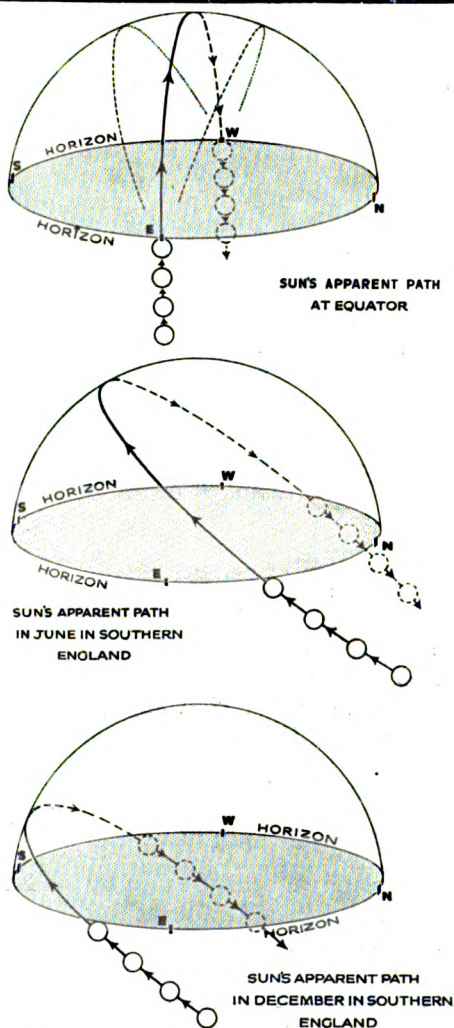
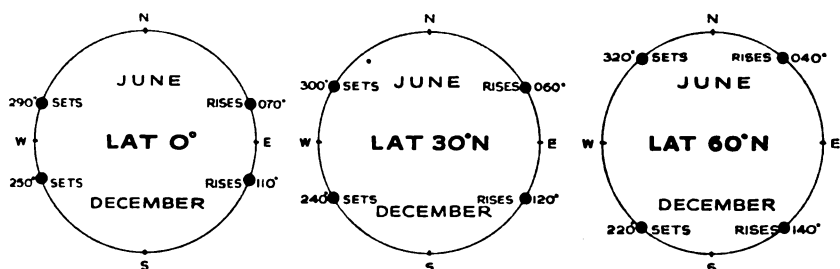


Fig. 400. Diagrammatic representation of the periods of twilight

Sun's Bearing at Sunrise and Sunset

The Sun is said to rise in the east and set in the west, but this is only a very general indication of its direction at these times, and is of little practical value to the seaman. Between the arctic and antarctic circles, on the occasions of the equinoxes, the Sun rises and sets all over the world within two degrees of due east and west. At any one place between these latitudes and between the equinoxes and the solstices, the Sun will appear to rise or set progressively further northward or southward of due east or west, according to the latitude of the place and the date. In the northern hemisphere, from March 21st to June 21st the bearings will increase progressively northward of due east and west, and then from June 22nd to September 22nd they will decrease progressively back to due east or west. From September 23rd to December 21st the bearings will increase progressively southward of due east and west, and from December 22nd to March 21st they will decrease progressively back to due east or west. The same progression will occur at places in the southern hemisphere, but in reverse directions. Diagrammatic representations of the progressive variation in the bearings of the rising and setting Sun in the northern hemisphere, for the three latitudes of the Equator, of 30° N, and of 60° N, are shown in Fig. 401.



APPROXIMATE DIRECTION OF THE SUN AT RISING AND SETTING IN JUNE AND DECEMBER, FOR LATITUDES OF THE EQUATOR, 30° N AND 60° N

Fig. 401.

The Abridged Nautical Almanac.—This book is compiled under the direction of the Astronomer Royal and published yearly by order of the Admiralty. In it are given all the variable astronomical tables necessary to the seaman for navigational purposes. The use of the Nautical Almanac for finding the times of sunrise, sunset, and twilight, and the times of the sun's rising and setting, are explained later in this chapter under the heading of "Time".

TIME

The Day

The interval of time taken by the Earth to complete one revolution relative to the Sun is called a "solar day", of which there are two kinds, namely the "apparent solar day" and the "mean solar day". An apparent solar day is measured from the moment the Sun appears to cross the meridian of an observer (apparent noon) to the moment it again appears to cross the same meridian. This interval is not constant because of the elliptical path of the Earth around the Sun, and the variation of the Earth's speed along its path.

It would be very inconvenient to have to work to a day of variable length, so an artificial day, called a "mean solar day", is used as the common unit of time. This day is equal in length to the mean length of all the apparent solar days in the year. An ordinary clock is regulated to keep "mean time", whereas a sundial shows "apparent time". Apparent time may be fast or slow on mean time by an amount varying between the limits of 51 minutes fast and 14 minutes slow.

The mean day is divided into 24 hours, each hour is divided into 60 minutes, and each minute into 60 seconds.

The Month

The period of a month was originally based on the interval of time taken by the Moon to make one circuit of the Earth (*i.e.* about $29\frac{1}{2}$ days). By this system the monthly cycle became completely out of step with the yearly cycle, and in 1582 the "Gregorian calendar" was introduced by Pope Gregory XIII, in which the monthly cycle was arranged so as to coincide with the yearly cycle.

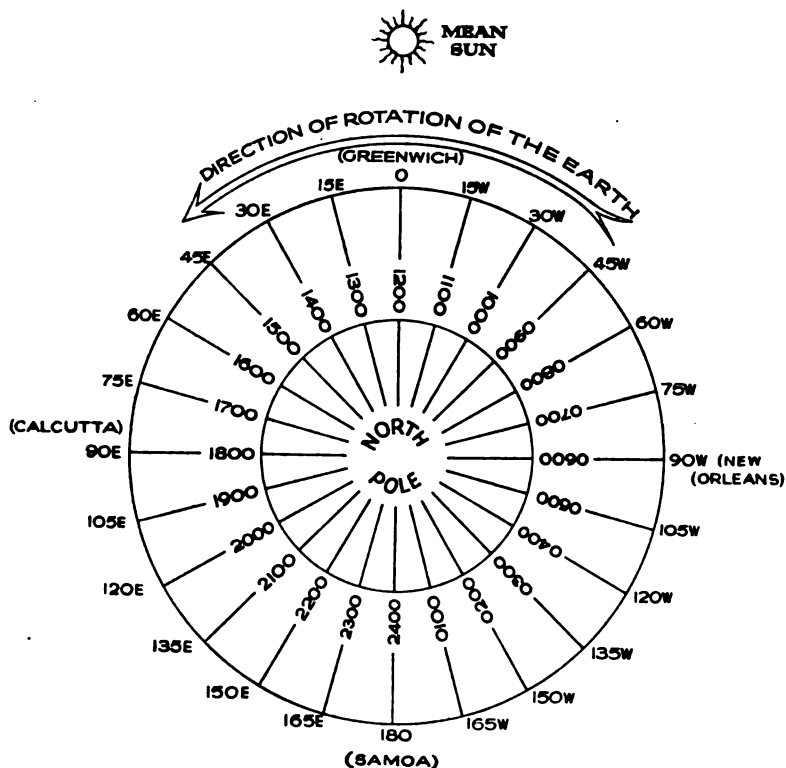
The Year

The time taken for the Earth to complete one circuit of the Sun is called a year, which comprises 365 days. Measured in units of mean time one year is actually 365 days, 5 hours, 48 minutes and 46 seconds, so that eventually, unless corrected, the calendar would become out of step with the yearly cycle. A "leap year" is therefore introduced every fourth year, in which an extra day (February 29th) is introduced into the calendar. This method of correction slightly "overcorrects" the error, so three leap years are omitted every four centuries; the years 1700, 1800 and 1900 were therefore made ordinary years, but the year 2000 will be made a leap year.

Longitude and Time

The Earth revolves about its axis in an easterly direction, completing one revolution in 24 hours, during which it revolves through 360 degrees of arc or longitude. There is, therefore, a relationship between longitude and time; 15 degrees of longitude being equivalent to one hour of time. This relationship is illustrated by Fig. 402, in which the Earth is represented in a position corresponding to noon along the meridian of Greenwich. At this moment the time at Calcutta (longitude 90° E) will be 1800, and the time at New Orleans (longitude 90° W) will be 0600; a difference in each case of six hours for a change of longitude of 90 degrees. It should be noted that times in easterly longitudes are progressively greater than the time at Greenwich, and times in westerly longitudes are progressively less, so that a person travelling eastward would have to advance the hands of his watch one hour for every 15 degrees change of longitude, and a person travelling westward would have to retard them one hour for every 15 degree change of longitude.

To convert longitude into time the longitude should be divided by 15; and to convert time into longitude the time should be multiplied by 15. The two following examples suffice to explain the method.



THE EARTH AS VIEWED FROM ABOVE THE NORTH POLE
IN THE POSITION OF NOON GREENWICH MEAN TIME

Fig. 402. Diagrammatic representation of longitude and time

Example 1 :—

What change of longitude corresponds to a difference in time of 9 hours, 27 minutes, 10 seconds ?

$$10 \text{ seconds} \times 15 = 150''; \div 60 = 0^\circ 02' 30''$$

$$27 \text{ minutes} \times 15 = 405'; \div 60 = 6^\circ 45' 00''$$

$$9 \text{ hours} \times 15 = 135^\circ 00' 00''$$

$$9 \text{ hours, 27 minutes, 10 secs.} = \underline{141^\circ 47' 30''}$$

Example 2 :—

What difference in time corresponds to a change of longitude of $10^\circ 47' 15''$?

$$15 \mid 10^\circ 47' 15'' \text{ (0 hours, 43 minutes, 9 seconds.)}$$

$$647' \dots\dots\dots (10^\circ \times 60 + 47')$$

$$60 \dots\dots\dots (4 \times 15)$$

$$\underline{47}$$

$$45 \dots\dots\dots (3 \times 15)$$

$$\underline{2}$$

$$135'' \dots\dots\dots (2' \times 60 + 15'')$$

$$\underline{135} \dots\dots\dots (9 \times 15)$$

Local Mean Time and Greenwich Mean Time

Local Mean Time (L.M.T.).—The time at any place calculated with reference to the mean Sun is called "local mean time" or in short, L.M.T. This time is used for calculations involved in astronomical and navigational problems, but need not necessarily be the civil time kept at that locality.

Greenwich Mean Time (G.M.T.).—For the solution of astronomical and navigational problems it is convenient to have some basic time with which other time may be compared. By international agreement this basic time is the local mean time for the Greenwich meridian, and is called "Greenwich mean time", or in short G.M.T. L.M.T. will differ from G.M.T. by an amount equivalent to the difference between the longitude of the place and that of Greenwich. When comparing L.M.T. with G.M.T. the following couplet provides a good guide :—

*Longitude East, Greenwich Time Least,
Longitude West, Greenwich Time Best.*

The Date

The date at a place is deemed to change at midnight L.M.T., at which time the "anti-meridian" of that place is passing beneath the mean sun. The anti-

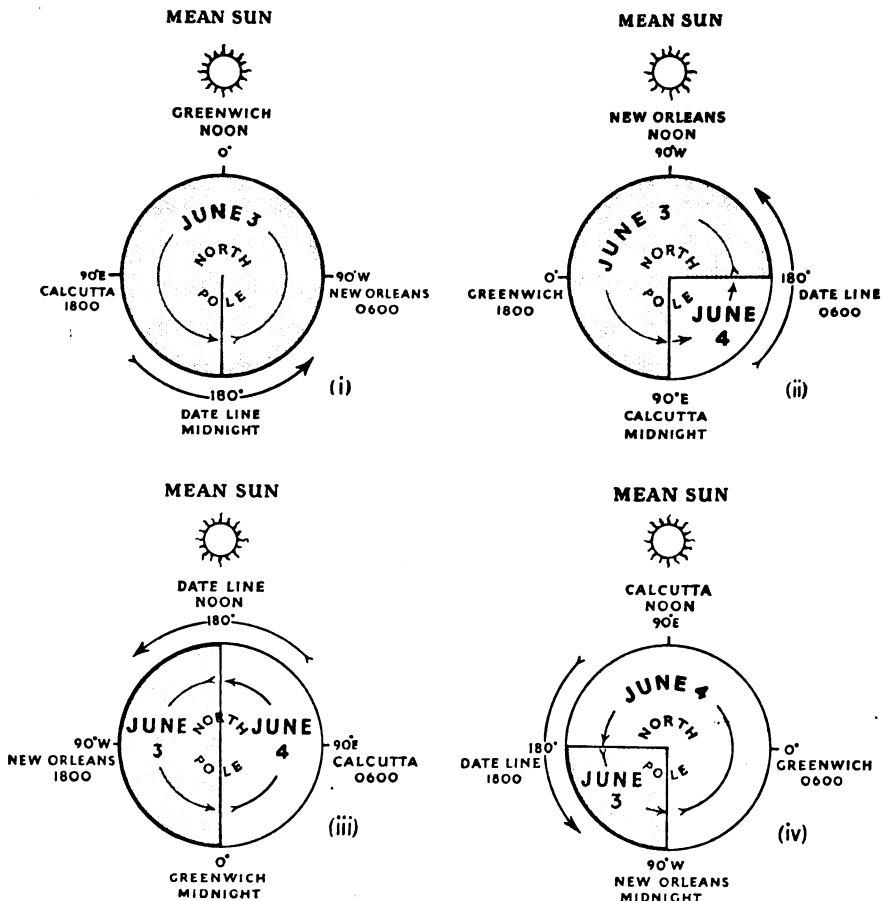


Fig. 403. Diagrammatic representation of the change of date

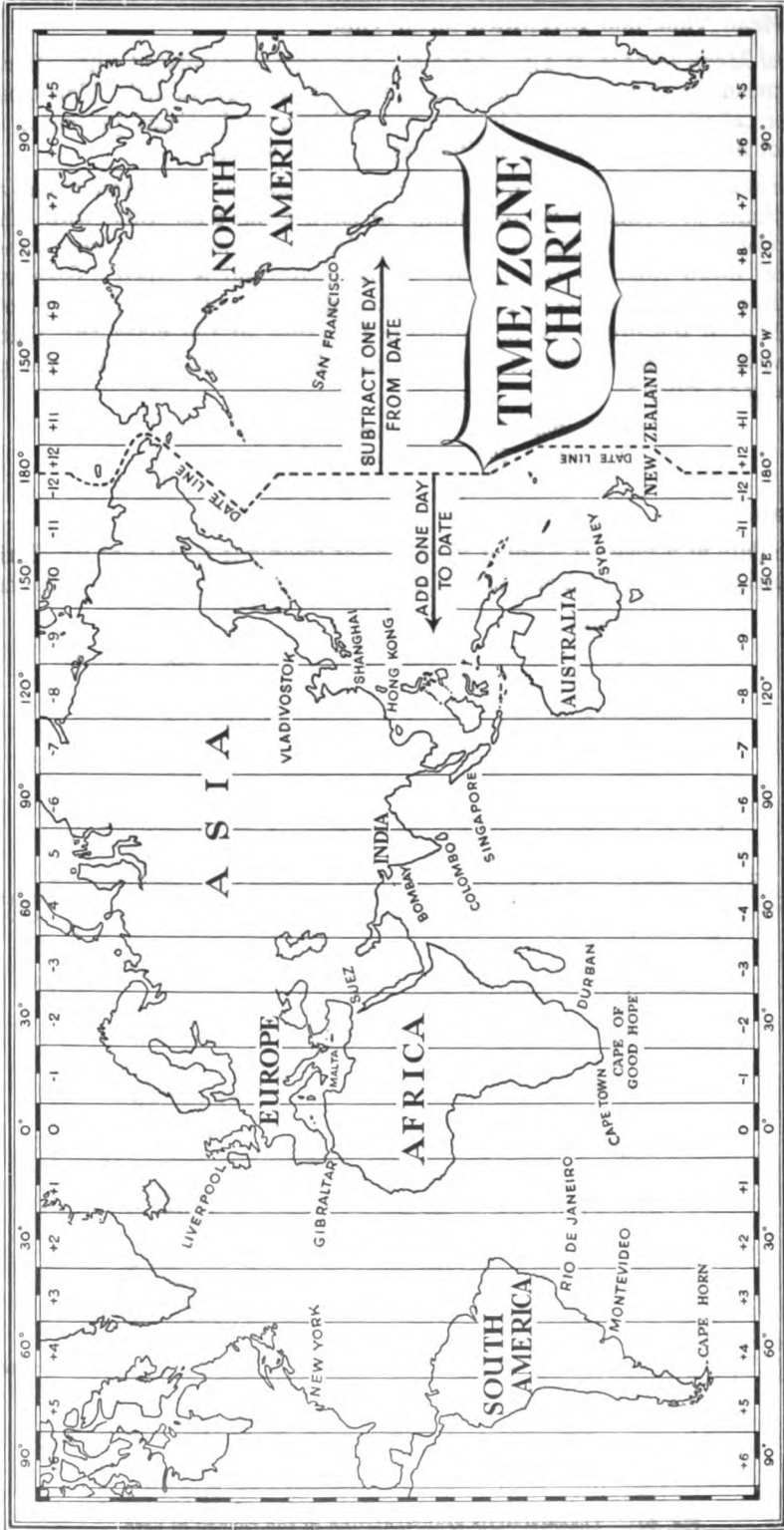


Fig. 404.

meridian of a place is its corresponding meridian on the far side of the world. By international agreement, the boundary line between one day and the next lies along the 180th meridian, which is the anti-meridian of Greenwich, and this boundary is called the "date line". At only one moment in the 24 hours is the date the same all over the world, and that moment is 1200 hours G.M.T. Immediately after this time the new day starts to unfold eastwards from the date line, and the date at one place may then be different from the date at another.

The four diagrams in Fig. 403 represent four stages of a new day as it unfolds round the world. In each diagram the Earth is represented as it would be viewed by an observer from above the North Pole, with the Earth revolving eastward anti-clockwise. On the perimeter of each circle are marked the meridians of Greenwich (zero), New Orleans (90° W), the date line (180°), and Calcutta (90° E).

For reasons similar to those which governed the choice of G.M.T. as the basic time, the date along the meridian of Greenwich has been chosen as the basic date and is called the "Greenwich date" (G.D.). The two following examples show the method of converting the "local date" (L.D.) and L.M.T. to the G.D. and G.M.T. and *vice versa*. Where a change of date is involved, 24 hours are "borrowed" as necessary.

Example 1 :—

What are the G.D. and G.M.T. when the L.D. and L.M.T. are June 3, 0800, at a position in longitude 160° 15' E ?

Long. 160° 15' E converted to time = 10 hrs. 41 mins. E.

L.D. and L.M.T. = June 3, 08. 00. 00. (borrow 24 hours).

Long. in time	=	10. 41. 00. E	(Long. East Greenwich time
			Least—subtract).

G.D. and G.M.T. = June 2, 21. 19. 00.

Example 2 :—

What are the L.D. and L.M.T. at a position in longitude 135° 45' W, when the G.D. and G.M.T. are June 3, 0900 ?

Long. 135° 45' W converted to time = 9 hours, 3 mins. W.

G.D. and G.M.T. = June 3, 09. 00. 00. (borrow 24 hours).

Long. in time	=	09. 03. 00. W	(Long. West Greenwich time
			Best—subtract).

L.D. and L.M.T. = June 2, 23. 57. 00.

Zone Time

As a ship steams eastward or westward it would be very inconvenient to alter the clocks a minute or so at a time to keep in step with the change of longitude and local time. The surface of the globe has therefore been divided into a number of zones, each comprising 15 degrees of longitude and thus representing one hour of time.

The zones are numbered from zero to 12, west and east, from the Greenwich meridian, and are qualified by a plus or minus sign, plus for westerly zones and minus for easterly zones. A representation of the "Time-zone Chart" is shown in Fig. 404, from which it will be seen that the zero zone lies on each side of the Greenwich meridian, and the 12th zone lies on each side of the date line.

The boundaries of each zone lie at $7\frac{1}{2}$ degrees on each side of the central meridian of the zone, and each central meridian is a multiple of 15. For example, the central meridian of zone + 4 is 15 multiplied by 4, *i.e.* 60° W; and the boundaries of this zone lie at 60 degrees plus and minus $7\frac{1}{2}$, *i.e.* at $67\frac{1}{2}^\circ$ W and $52\frac{1}{2}^\circ$ W.

Within the boundaries of any zone a ship keeps the time of that zone, which is a whole number of hours greater or less than G.M.T. The time kept within a zone (Z.T.) is the L.M.T. of its central meridian, and this time will not differ by more than 30 minutes from the L.M.T. of the ship. As the ship passes from one zone to another, her clocks are advanced or retarded one hour in accordance with her progression eastward or westward.

TO CONVERT "ZONE DATE" (Z.D.) AND "ZONE TIME" (Z.T.) TO GREENWICH DATE AND GREENWICH MEAN TIME, AND VICE VERSA

The zone number is added or subtracted as necessary from the zone time or the Greenwich mean time. The following two examples show the manner in which the conversion is done.

Example 1 :—

What are the G.D. and G.M.T. when the Z.D. and Z.T. are September 23, 19. 22. 45 at a position in Zone + 9?

$$\begin{array}{rcl}
 \text{Z.D. and Z.T.} & = & \text{Sept. 23, 19. 22. 45.} \\
 \text{Zone + 9} & = & \text{09. 00. 00. W (Long. West Greenwich time} \\
 & & \text{Best—add).} \\
 \hline
 \text{G.D. and G.M.T.} & = & \text{Sept. 24, 04. 22. 45 (or 28. 22. 45. Sept. 23).}
 \end{array}$$

Example 2 :—

If the G.D. and G.M.T. are September 23, 07. 32. 30., what are the Z.D. and Z.T. at a position in Zone + 10?

$$\begin{array}{rcl}
 \text{G.D. and G.M.T.} & = & \text{Sept. 23, 07. 32. 30 (borrow 24 hours).} \\
 \text{Zone + 10} & = & \text{10. 00. 00. W (Long. West Greenwich time} \\
 & & \text{Best—subtract).} \\
 \hline
 \text{Z.D. and Z.T.} & = & \text{Sept. 22, 21. 32. 30.}
 \end{array}$$

TO CONVERT ZONE TIME TO LOCAL TIME, AND VICE VERSA

The change of longitude between the position and the central meridian of the zone is converted to a "time difference" which is then applied to the given time. The method of doing this is shown in the two following examples.

Example 1 :—

What is the Z.T. at a position in longitude $47^\circ 21' \text{ W}$ when the L.M.T. is 19. 23. 00?

Long. $47^\circ 21' \text{ W}$ converted to time equals 3 hrs. 9 mins. 24 secs. W. therefore the zone is + 3, and its central meridian is 45° W (3×15).

Long. of position = $47^\circ 21' \text{ W}$.

Long. of central meridian = $45^\circ 00' \text{ W}$.

Change of Long. = $2^\circ 21' \text{ easterly (i.e. from the position to the central meridian).}$

Change of Long. converted to time = 0 hrs. 9 mins. 24 secs. Easterly.

L.M.T. = 19. 23. 00.

Change of Long. = 00. 09. 24 *easterly* (therefore add).

Z.T. = 19. 32. 24.

Example 2 :—

What is the L.M.T. at a position in longitude $118^{\circ} 17' E$ when the Z.T. is 19. 21. 17 ?

Long. $118^{\circ} 17' E$ lies in zone — 8, whose central meridian is $120^{\circ} E$ (8×15).

Long. of central meridian = $120^{\circ} 00' E$.

Long. of position = $118^{\circ} 17' E$.

Change of Long. = $1^{\circ} 43'$ *westerly* (i.e. from the central meridian to the position).

Change of Long. converted to time = 0 hrs. 6 mins. 52 secs. *Westerly*.

Z.T. = 19. 21. 17.

Change of Long. = 0. 06. 52 *westerly* (therefore subtract).

L.M.T. = 19. 14. 25.

Standard Time

The division of the world into time zones is very suitable for ships on the high seas, but the unqualified adoption of this system of time-keeping might be very inconvenient ashore. "Standard time" is a modified version of the zonal time system, altered as necessary to suit the geographical boundaries and internal administration of the countries concerned. In certain countries, including Great Britain, "summer time" is kept. This is usually one hour in advance of the normal standard time of the country. Standard times for countries and places throughout the world are published in the *Nautical Almanac*.

To Find the Times of Sunrise and Sunset

In the *Abridged Nautical Almanac* the times of sunrise and sunset are given for every two consecutive days throughout the year for certain latitudes between $N. 72^{\circ}$ and $S. 55^{\circ}$, inclusive. Times of sunrise are given under the alternate dates appearing on the left hand pages of the book, and the times of sunset are given under the intervening dates appearing on the right hand pages. These times are correct to within a minute for the two days to which they refer, and they are expressed as local mean time. To obtain the zone time or standard time of sunrise or sunset at any particular place, local mean time must be converted to Greenwich mean time, and then converted to the zone time or the standard time of that place.

Example.—What is the standard time of sunset on January 1, 1952, and the standard time of sunrise on the following day at Port Carnarvon on the west coast of Australia ?

From the almanac it is found that the standard time kept on the west coast of Australia is minus 8 hours.

From the *Australia Pilot, Volume V*, it is found that Port Carnarvon lies in latitude $S. 24^{\circ} 45'$ and longitude $E. 113^{\circ} 09'$.

In the almanac January 1 appears on a left hand page, and January 2 on the opposite page ; the sunrise and sunset tables for the two days appear on the left and right hand pages respectively.

From the sunset table :—

	S. 20°	S. 30°
L.M.T. of sunset, Jan. 1	= 18 hrs. 43 mins.	19 hrs. 05 mins.
	Difference = 22 mins.	
Interpolation for 4° 45' latitude	= 11 mins.	
L.M.T. of sunset Jan. 1 in S. 24° 45'	= 18 hrs. 43 mins. + 11 mins.	
	= 18 hrs. 54 mins.	
113° 09' of longitude	= 7 hrs. 33 mins. E. —	
G.M.T. of sunset Jan. 1 at Port Carnarvon	= 11 hrs. 21 mins.	
Standard time correction	= 08 hrs. 00 mins. +	
S.T. of sunset Jan. 1 at Port Carnarvon	= 19 hrs. 21 mins.	

From the sunrise table :—

From the sunrise table:

	S. 20°	S. 30°
L.M.T. of sunrise, Jan. 2 =	05 hrs. 24 mins.	05 hrs. 02 mins.
	Difference = 22 mins.	
Interpolation for 4° 45' latitude	= 11 mins.	
L.M.T. of sunrise Jan. 1 in 24° 45'	= 05 hrs. 24 mins. — 11 mins.	
	= 05 hrs. 13 mins.	
113° 09' of longitude	= 7 hrs. 23 mins. —	
G.M.T. of sunrise Jan. 1 at Port Carnarvon	= 21 hrs. 40 mins. Jan. 1	
Standard time correction	= 08 hrs. 00 mins. +	
S.T. of sunrise Jan. 2 at Port Carnarvon	= 05 hrs. 40 mins.	

To Find the Times of Twilight

The times of the beginning and ending of civil twilight are to be found on the same pages of the Nautical Almanac as the corresponding times of sunrise and sunset, and the actual times for any date or latitude are found in a similar manner to those of sunrise and sunset. It should be remembered that before sunrise the time marks the beginning of the corresponding twilight, and that after sunset the time marks the end of the corresponding twilight.

In high latitudes the Sun is, for certain periods of the year, below the horizon all day, and for other periods it is above the horizon all day ; also, for certain periods twilight lasts all night or does not occur at all. In this connection the following symbols are to be found where they apply :—

- S.A.H. = Sun above the horizon all day ;
- S.B.H. = Sun below the horizon all day ;
- T.A.N. = twilight all night ;
- N.C.T. = no civil twilight.

The times of the beginning and ending of nautical twilight can be found by applying a time correction, representing the duration of nautical twilight, to the corresponding times of civil twilight. The amount of this time correction is given in an auxiliary table in another part of the *Nautical Almanac* and it is found and applied in the manner described below.

Assuming that the Sun rises above the horizon during the day, first find the duration of civil twilight, that is the difference between the times of sunrise and civil morning twilight or the difference between the times of civil evening twilight and sunset. Now turn to the auxiliary table, which is in two main parts, one for winter months and one for summer months. Enter the appropriate part of the table with the duration of civil twilight against the appropriate latitude and find the necessary time correction. Then subtract the time correction from the time of civil morning twilight to obtain the time of nautical morning twilight, and add the time correction to the time of civil evening twilight to obtain the time of nautical evening twilight. These times are local mean times and are correct to within three minutes.

A third part of the auxiliary table provides for the few occasions when the Sun remains below the horizon all day. The time correction for these occasions is found by entering the third part of the table with the time of civil twilight, instead of its duration, against the appropriate latitude.

Example :—

What are the local mean times of morning and evening nautical twilight in latitude N. 66° on January 2, 1952 ?

From the daily pages of the *Abridged Nautical Almanac*, 1952, under January 2 for latitude N. 66° :—

	L.M.T.		DURATION OF CIVIL TWILIGHT	
	hrs.	mins.	hrs.	mins.
civil morning twilight =	08	54	01	35
Sunrise =	10	29		
Sunset =	13	39		
			01	34
civil evening twilight =	15	13		

From the auxiliary table of the *Abridged Nautical Almanac*, 1952, under the part headed " January to March and October to December " :—

time correction under duration of civil twilight of 01 hrs. 35 mins., and against latitude N. 66° is 01 hrs. 15 mins.

Therefore :—

L.M.T. of nautical twilight in latitude N. 66° on January 2, 1952, are :—

morning—08 hrs. 54 mins. — 01 hr. 15 mins. = 07 hrs. 39 mins., and
evening—15 hrs. 13 mins. + 01 hr. 15 mins. = 16 hrs. 28 mins.

These times will have to be corrected in the manner shown in the previous example to obtain the zone times or the standard times of nautical twilight.

Chronometers, Watches and Clocks

For navigational purposes it is essential that the recorded time should be accurate to within a few seconds. This can be readily appreciated when it is remembered that four seconds of time are equivalent to one minute of longitude. For navigational purposes ships are therefore supplied with three special types of time-keeping instruments, namely, "chronometers", "chronometer watches" and "deck watches".

These chronometers and watches are delicate and expensive instruments which are very liable to damage, and their accuracy can easily be adversely affected by mishandling, shock or vibration. For these reasons the instructions on the care and handling of such instruments, as described in the *Admiralty Navigation Manual*, should always be closely followed.

In a ship chronometers and chronometer watches are stowed in special stowage boxes in the charthouse which are made as free as possible from damp, vibration, shock from gunfire and the effects of the ship's movements in a seaway.

Deck watches are supplied for general time recording in connection with the navigation of the ship, and are designed to maintain reasonable accuracy for short periods. Their errors are checked daily (or more often if necessary) by comparison with radio time signals or with the ship's chronometer. They should always be kept in their cases and handled with care.

RATE

It is not possible to construct a ship's chronometer which would always maintain exact mean solar time, but it is possible to construct one which will lose or gain time at a regular rate of so many seconds in 24 hours, so that the error at any time can be computed and applied to the time recorded by the chronometer to obtain the correct mean solar time.

The time recorded by a chronometer is checked at regular intervals of from five to ten days, usually by wireless time signals, and its daily rate is computed and noted in the *Chronometer Comparison Book (Form N.387)*, commonly called the "chronometer log". The rate of a deck watch is recorded on a slip of paper which is kept with the watch in its case.

Chronometers and watches are wound daily at a regular time, usually just before 0900, at which hour they are usually reported wound to the Commanding Officer.

Time kept in H.M. Ships

Chronometers are usually first started approximately at Greenwich mean time, and thereafter the position of their hands is never altered, their errors being noted as fast or slow on G.M.T.

Deck watches and signal clocks are set to zone time, the hands being moved at the time the ship passes from one zone to the next.

At sea, ship's clocks are set to zone time, the alteration being made in one or two steps so as to disturb the routine of the ship as little as possible. When clocks have to be advanced it is usually best to advance them one hour at 2330, and when they have to be retarded it is usual to put them back one hour at 1830, the watches changing at 1830. This shares the change equally between the watches.

In harbour the ship's clocks are set to the standard time of the country or place where the harbour is situated.

THE MOON

An elementary knowledge of the Moon's movements in relation to the Earth is necessary to the seaman, because the moon largely influences the rise and fall of the tides and hence the movement of tidal streams.

The Moon's Orbit

The Moon travels round the Earth in a very similar manner to that in which the Earth travels round the Sun. The Moon's orbit also is elliptical, and she travels along it in the same direction (anti-clockwise) as that in which the Earth spins.

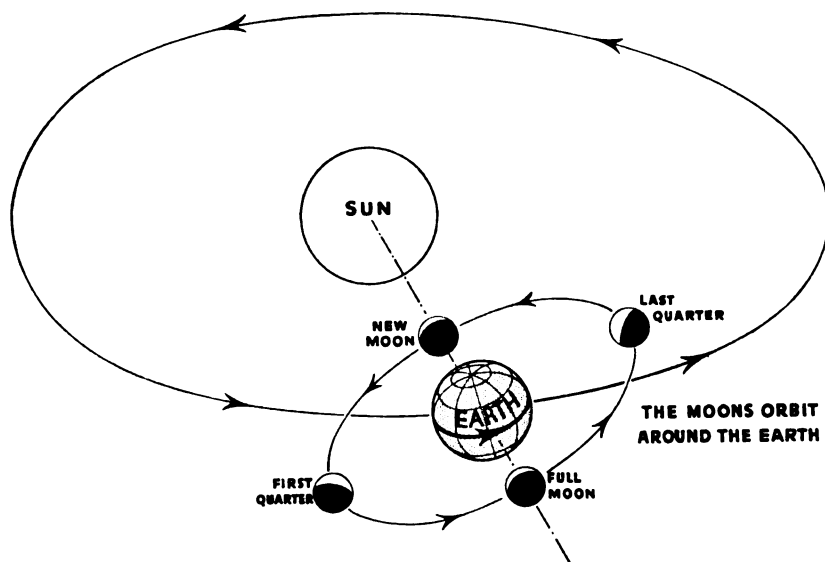


Fig. 405. The Moon's orbit round the Earth

The angle between the plane of the Moon's orbit and the plane of the equator changes by about one degree every year, and in the course of 19 years it changes from $18\frac{1}{2}$ to $28\frac{1}{2}$ degrees and back to $18\frac{1}{2}$. The maximum declination of the Moon in any one year may therefore be anything between $18\frac{1}{2}$ and $28\frac{1}{2}$ degrees north or south of the equator, and she will cross the equator twice in the course of one circuit.

The time taken by the Moon to complete one circuit round the earth, commonly called a "lunar month", is approximately $29\frac{1}{2}$ mean solar days, reckoned from one new Moon to the next. During the course of her orbit the Moon makes one revolution about her axis.

Phases of the Moon

At one point in her orbit the Moon passes between the Earth and the Sun, and at the opposite point of her orbit she passes on the side of the Earth farthest from the Sun; at the former point she is said to be a "new Moon", and at the latter a "full Moon". Throughout her path between the positions of new Moon and full Moon she is said to be "waxing", and half way through it she reaches a point called "first quarter"; throughout her path from full Moon

to new Moon she is said to be “waning”, and half way through it she reaches a point called “last quarter” (see Fig. 367 on page 652). These four positions are known as the “phases of the Moon”, and are symbolically represented in print as shown below.

New Moon = ●

Full Moon = ○

First quarter =)

Last quarter = (

The “age of the Moon” is the number of days which have elapsed since last being a new Moon; in a lunar month of 30 days the Moon is therefore $7\frac{1}{2}$ days old at her first quarter, $14\frac{1}{2}$ days old at full Moon, and $22\frac{1}{2}$ days old at the last quarter.

Appearance of the Moon

The Moon, like the Earth, does not actively radiate light, and her visibility is due to the reflection of the Sun's rays from her surface to us. The area and shape of the Moon's reflected surface, as viewed from the Earth, therefore changes with her position in her orbit, and so has a different shape in each phase (see Fig. 367, page 652).

At the exact time of new Moon she is actually invisible, but just either side of new Moon the crescent moon will be seen, which, if waxing is commonly called the new Moon, and if waning, the “old Moon”.

At the first and last quarters exactly half of the Moon will be visible, and at full Moon the whole of her reflected surface is seen. The age of the Moon can therefore be estimated roughly from the apparent area of her reflected surface.

Attitude of the Moon

The Moon's attitude depends upon the latitude of the observer, the age of the Moon, and the Moon's declination.

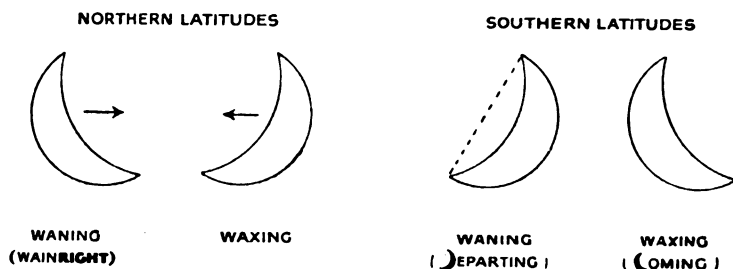


Fig. 406. Appearance of the Moon when waxing and waning

In latitudes north of 27° N., the Moon will always face to the *left* when *waxing* and to the *right* when on the *wane*. This is easily remembered if the English name of *Wainright* is given to the Moon.

In latitudes south of 27° S. the opposite occurs, and this can be memorised by describing the condition of the Moon as either “*Coming*” or “*Departing*”, and likening her shape to the initial letters *C* or *D* of these words.

Between these latitudes the Moon's attitude when waxing or waning will depend on whether her declination at the time is northward or southward of the observer, because in her monthly orbit the Moon may change her declination as much as from 28° N. to 28° S. If her declination is southward of the observer,

the *Wainwright* rule will apply ; and if northward, the *C* and *D* rule will apply.

Moonrise and Moonset

Because the Moon travels along her orbit in the same direction as the Earth revolves, the period of a lunar day will exceed that of a solar day, and moonrise and moonset will therefore occur later each day by a period which averages about 50 minutes in the course of a lunar month. Because the plane of the Moon's orbit is inclined to the plane of the equator, the difference between the times of moonrise or moonset on one day and the next will depend upon the declination of the Moon at the time, as well as upon the latitude of the observer ; they may therefore differ largely from the monthly average of 50 minutes. At the equator, for example, this "lag" may vary from 39 to 65 minutes ; in latitude 52°N. it may vary from 9 to 97 minutes ; and in high latitudes there may be no moonrise or moonset for several days in succession because during these periods the moon may remain below or above the horizon, thus simulating the periods of continuous darkness and daylight experienced in these latitudes in their winter and summer seasons.

L.M.T. of moonrise and moonset on the meridian of Greenwich between latitudes 73°N. and 60°S. are given in the Nautical Almanac for every day of the year, and if the observer is not on the meridian of Greenwich corrections for longitude will have to be applied to these times, the procedure for which is explained in the Nautical Almanac.

If moonrise occurs shortly before midnight (which very often happens when the Moon is nearing or leaving her last quarter) the Moon will not rise again until shortly after midnight the following day, and therefore there will be no time of moonrise on that day. The same applies to the time of moonset when it occurs shortly before midnight (which often happens when the Moon is nearing or leaving her first quarter).

The following generalisations may be useful for estimating the period of moonlight on any particular night in any but high latitudes : a new Moon sets shortly after sunset ; a first quarter Moon sets approximately at midnight ; a full Moon rises approximately at sunset and sets approximately at dawn ; a last quarter Moon rises approximately at midnight ; an old Moon rises shortly before dawn.

THE PLANETS

In addition to the Earth there are many other heavenly bodies which travel round the Sun, and which depend upon his attractive force for their position in space. These satellites of the Sun are called "planets", and together with the Sun and the Earth they comprise what is generally known as the "solar system". Like the Earth none of these planets themselves radiate light, and their visibility from other planets depends upon the amount of sunlight they reflect. Many of these planets are invisible from the Earth because of their small size or great distance from us.

Fig. 407 shows the relative positions of the chief planets in the solar system, their average distance from the Sun in millions of miles, and the periods of their orbits around the Sun. The relative sizes of the planets can be imagined from the homely simile that if the Sun is represented by a balloon about 4 feet in diameter, then Jupiter and Saturn could each be represented by a grape-fruit, Venus and the Earth by small cherries and Mars by a pea.

Because of their movement around the Sun the relative positions of the planets to each other are constantly changing, and this rate of change is not in phase with the Earth's movements. As viewed from the Earth their positions in the heavens are therefore different, not only from day to day and month to month but also from year to year. As their paths are restricted to the region of the celestial equator they are always seen in the southern sky from British or similar northern latitudes. Planets shine with a steady lustre, but all stars more or less twinkle; some planets may also be distinguished from stars by their greater brightness.

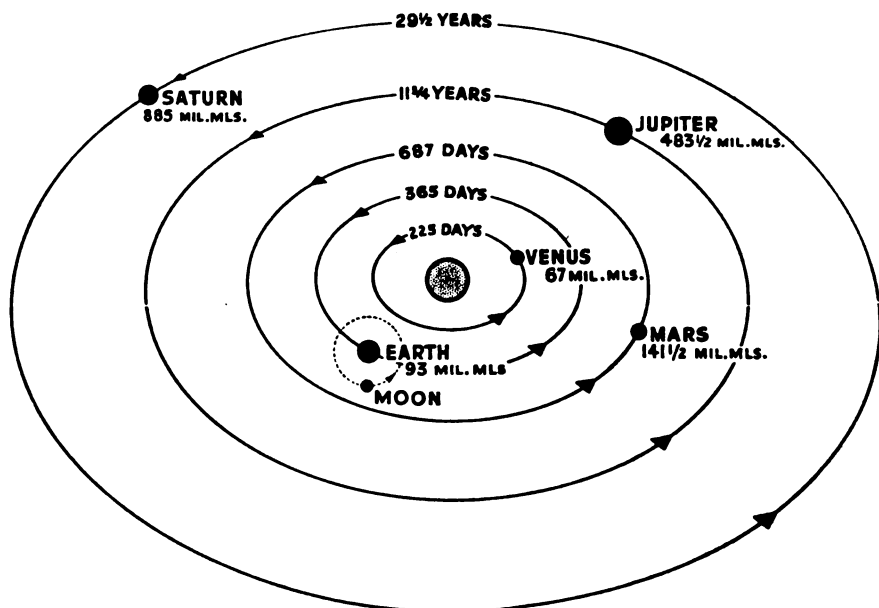


Fig. 407. Diagrammatic representation of the solar system

Venus always appears near the Sun, either behind or ahead of him and never more than 47 degrees or 3 hours from him; she can be seen with the naked eye in daylight, but is most evident at dawn and dusk on the eastern and western horizons, and so is widely known as the "morning" or "evening star". When seen as the morning star she will be in advance of the Sun and will rise and set before him, but when seen as the evening star she will be following the Sun and will rise and set after him. With these characteristics the identification of Venus is seldom difficult.

Mars is of varying brightness, but may sometimes be distinguished by his faint, red tint.

Jupiter is usually a little brighter than any of the stars, and, like most planets, shines with a slightly warmer light than the stars.

Saturn is the least conspicuous of the larger planets, and so may be mistaken for a star.

THE STARS

A star is a heavenly body which, like the Sun, gives out light and heat on its own account. Also like the Sun a star may have its own satellites revolving around it in a planetary system of its own. The stars number countless

millions and the space in which they are situated is apparently limitless, so that a conception of the universe is difficult for mere man to comprehend. Some idea of the size of the universe may be gained from the fact that Alpha Centauri, the nearest star to the solar system, is 26 million million miles distant from us and its light takes more than four years to reach the Earth. In other words, if this star were suddenly snuffed out its disappearance would not be noticed by us until more than four years later.

The Celestial Sphere

For practical purposes the positions of stars in relation to the Earth can be taken as being fixed in direction, and they can therefore be represented diagrammatically on the surface of a globe with the Earth at its centre.

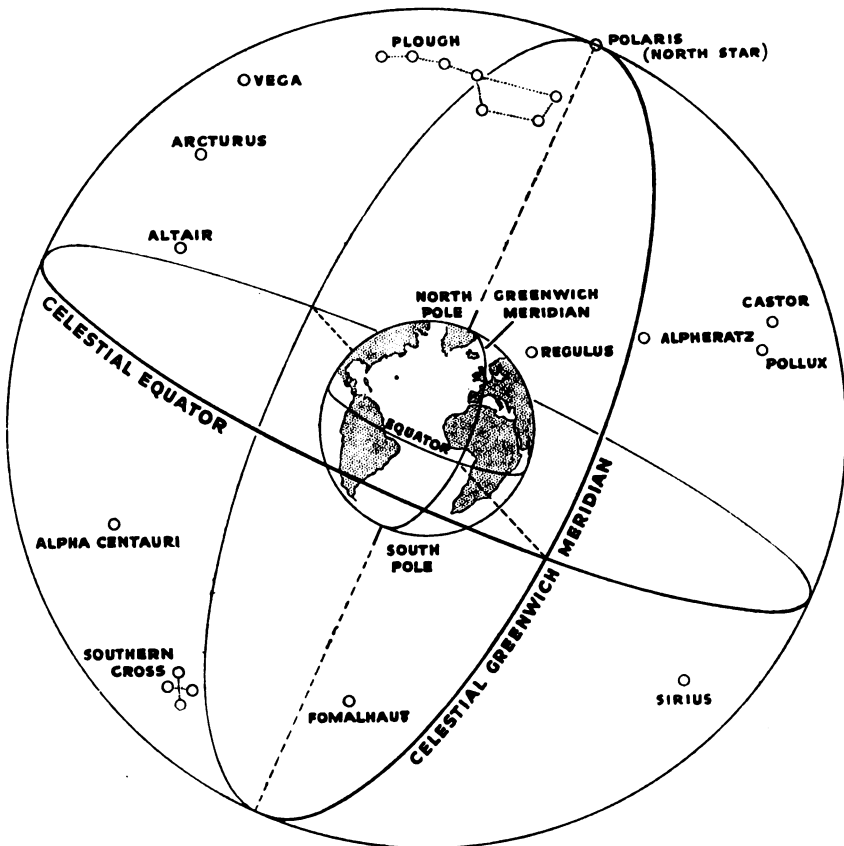


Fig. 408. The celestial sphere

The stars can therefore be plotted on a celestial sphere whose equator and north and south poles correspond with those of the Earth. On this sphere, latitude is represented by degrees of "declination" north or south of the celestial equator, and longitude is known as the "hour angle", measured in degrees from 0 to 360, or in hours from 0 to 24.

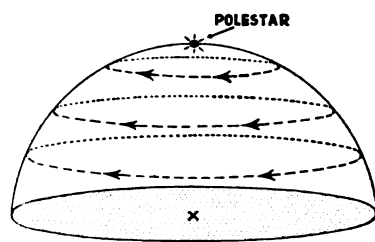
If this celestial sphere were factually correct, the sphere would be fixed while the Earth spun round inside it. For practical purposes, however, it is simpler to represent the Earth as being fixed and the sphere with its stars as revolving round it. This representation simulates the apparent movement of the stars in the heavens as viewed by an observer on the Earth, and because the celestial sphere is orientated so that its poles and equator correspond with those of the Earth, the stars will always appear to trace the same path through the heavens in relation to the Earth.

Appearance of the Night Sky

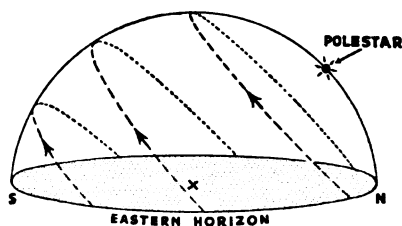
Because of the movement of the Earth along its orbit round the Sun, the stellar day is slightly shorter than the solar day. The period of the stellar day is actually about 23 hours 56 minutes, and when viewed at night the stars will therefore appear in positions four minutes in advance of their positions of the previous night. This accounts for the apparent change in the pattern of the night sky from month to month. Stars which may be seen during a December night may not be visible, say, on a June night, because they have risen and set in daylight. This daily four-minute advance of the stellar night amounts to 24 hours in the course of the 365 day year, and thus on each New Year's day the stellar and solar days are once more in step, and the yearly cycle begins again.

In theory, an observer on the equator should be able to see every star in the firmament at some time during the year, but as he moves away from the equator the stars of the opposite hemisphere will drop below his horizon in increasing numbers, and the stars of the hemisphere in which he is travelling will appear to rise progressively higher in the sky the nearer he approaches the pole. In Great Britain, for example, constellations such as the Southern Cross are never seen, but the Plough never falls below our horizon. It will be seen therefore that the aspect of the stars on any one night depends upon the day and month of the year and the latitude of the observer. The longitude of an observer has no appreciable effect on his aspect of the heavens; for example, an observer in Vancouver will see a night sky similar to that seen from the South coast of England, but about eight hours later.

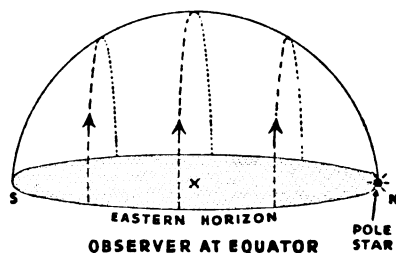
The angle with the horizon at which the stars appear to rise and set depends upon the latitude of the observer. To an observer at the North Pole the stars would appear to revolve round him in concentric circles with the Pole Star as their centre ;



OBSERVER AT NORTH POLE



OBSERVER AT 45°N



OBSERVER AT EQUATOR

Fig. 409. Angle with horizon at which the stars appear to rise and set

to an observer in mid-latitudes they would appear to rise at an angle with the eastern horizon, and set at a similar angle with the western horizon ; to an observer at the equator they would appear to rise vertically in the east and set vertically in the west. (See Fig. 409.)

Naming and Grouping of the Stars

From the earliest days of history man has relied on the stars to tell him the time at night, the direction in which he is going, and his approximate latitude. Groups of stars and individual stars were named in the languages of those who first used them ; this has resulted in their present conventional nomenclature being of mixed Phœnician, Arabic, Greek and Roman origin, and in their conventional grouping being often complicated and difficult for the beginner to understand.

It is important, however, that every seaman should have a general knowledge of the heavens so that he may find his direction at night by the stars when other means are not available. A much simplified map of the stars has, therefore, been designed to teach the young seaman the relative positions in the heavens of the more important stars and star groups. In this map only the more important stars have been included, and some of the conventional constellations have been re-grouped and re-named to form star groups which can be more readily identified.

By means of this map it should be easy to memorise the shapes of the various star groups and their relative positions in the sky, and thus to identify such stars of particular importance to the seaman as the Pole Star, the Northern and Southern Pointers, and the constellation of Orion.

The Star Map (Plate 5, after page 538)

The star map depicts the celestial sphere in two parts, each by a different method of projection ; the two parts are related to each other in the same way that a polar chart is related to a Mercator's projection of the world. The upper part, divided like a three-leafed clover, is constructed like a polar map, and shows the stars of the northern celestial hemisphere as viewed from the North Pole. All of these stars are visible at one time or another from the British Isles. The lower part depicts all of the celestial sphere north and south of the celestial equator, and is constructed in the same way as an ordinary chart based on Mercator's projection ; it thus includes the stars of the southern celestial hemisphere, most of which are never visible from the British Isles.

The size of each star as represented on this map indicates its brilliance and not its actual size ; the stars included are only those which can be easily seen on a clear night, and which form a star group or help to indicate the position of one. Some of the stars shown are numbered for purposes of reference ; of these only the 24 key stars of most importance to the seaman have been named.

The bright white pecked lines on the map indicate the shapes of constellations and star groups, and the direction of the Northern and Southern Pointers ; dull grey pecked lines link the star groups to one another to aid in their identification.

To aid comparison and correlation of the star groups on the two parts of the map, each is divided into three imaginary celestial continents, marked I, II and III.

HOW TO USE THE STAR MAP

An observer in the British Isles wishing to compare the *upper part of the map* with the heavens should hold it vertically with the viewed horizon directed downwards. If, for example, the observer is looking towards the constellation of Orion, the map should be held with its lower edge parallel with the horizon and his view would embrace the stars in Continent I below the Pole Star. The stars in Continents II and III would not be visible without turning his head, while the Pole Star and the stars beyond it would be above and behind his head. As the observer shifts his view to right or left, the map should be turned in a vertical plane clockwise or anti-clockwise, so that the view corresponds with the map. In practice this is readily achieved by noting the position of any recognised star group, such as the Plough, and turning the map in the vertical plane to correspond with it.

Similarly, when comparing the *lower part of the map* with the heavens, it should be held vertically and orientated until its viewed horizon is directed downwards. For example, if the map is held with its lower edge directed downwards, it would represent the heavens as viewed by an observer on the equator looking southward at a time of night when Orion was directly overhead. At this time Canopus (No. 45) would appear to be due south from the observer and fairly low in the sky; the Kite would appear south-eastward and just above the horizon; Achenar (No. 47) would be setting over the south-western horizon; and Sirius (No. 17) would be high up in the south-eastern quarter of the sky. All the stars in the sky northward of a line drawn through the centre of Orion would be behind the observer. The Sickel would be rising in the north-east; the Right-angle would be due north; and the Purse would be setting in the north-west. The Plough, The Book, and the Sceptre would rise later in the night, whereas the Square, the Diamond and the Peacock would already have set some hours previously.

The number of stars visible to an observer on any night will of course depend upon his latitude, the date, and the time of night.

Stars Indicating the Cardinal Points of the Compass

Certain stars and star groups enable the seaman to find his direction and approximate latitude without recourse to calculations or the use of instruments.

The Pole Star (Polaris) is to the seaman the most important star in the heavens. It always lies within $1\frac{1}{2}$ degrees of the line of the Earth's axis and therefore always indicates the approximate direction of true north. It is not a particularly brilliant star, but its position can be found from the alignment of other nearby stars, as described below.

The angle between the Pole Star and the horizon will give the latitude of the observer. In other words, if the Pole Star is directly overhead (at an angle of 90 degrees with the horizon) the observer must be at the North Pole, whereas if the Pole Star is on the horizon (angular measurement zero) the observer will be somewhere on or near the equator.

The Northern Pointers.—The direction in which the Pole Star lies (*i.e.* the direction of true north) is indicated by three sets of pointer stars which are situated in easily recognisable star-groups. These pointers are :—

- (i) the two end stars of the "Plough", Nos. 2 and 1 (Dubhe);
- (ii) the two stars which form one side of the "Cocked Hat", Nos. 21 and 20 (Deneb);

- (iii) the two least bright stars, Nos. 12 and 11, of the three which form the Right-angle of Capella, No. 10.

Orion.—When visible the figure of "Orion" is probably the most conspicuous in the heavens, and it lies across the celestial equator.

At the centre of this constellation lies a cluster of stars in the form of a square, with a pendant of smaller stars which appear to hang from one corner. This cluster is known as Orion's belt and the pendant as his sword. The sword points approximately southward.

The northernmost star of "Orion's belt" lies on the celestial equator, and to an observer on or near the equator this star will always rise due east and set due west. When this star is directly overhead the observer must be on the equator.

Southern Pointers.—In the southern hemisphere there is no clearly visible star corresponding to Polaris, but there are three sets of pointers from which an approximate direction of the South Pole can be obtained; these are described below.

- (i) The Southern Cross, which forms the head of the Sceptre and which is probably the most beautiful constellation of the Southern hemisphere. The long arm of the cross points a few degrees westward of true south. A nearer approximation to true south can be obtained by dropping a line from the head of the cross to pass close westward of the lower of the two stars below the cross. The cross can always be distinguished by its own two pointers, which lie horizontally and form the handle of the Sceptre.
- (ii) Nos. 41 and 40 (M.P. Dus.) of the Kite, which point within a degree or two of true south.
- (iii) Two Southern Pointers (Nos. 34 and 35) which lie adjacent to the Southern Cross and between it and the Kite, and also point within a degree or two of true south.

CHAPTER XXVII

The Weather

ALTHOUGH only the few remaining sailing craft now depend upon the vagaries of the wind to make their passages, an understanding of weather is still essential to every seaman.

The subject is fully dealt with in the *Admiralty Weather Manual*, and its more important features are explained in the *Admiralty Manual of Navigation*. The aim of this chapter is to present a brief outline of the facts concerning weather which every seaman should know, and to indicate the necessity for accurate, careful and punctual records of wind, sea and sky, and of the readings of the various meteorological instruments supplied to H.M. ships.

The Atmosphere

The phenomena that we describe as weather are caused by movements and other changing conditions of the atmosphere, or layer of air, which surrounds the earth. This contains oxygen, nitrogen and small amounts of other gases, and also varying amounts of water vapour which cause cloud, rain and fog, and make the temperature equable. The movements of the atmosphere are caused by the heat of the Sun, the rotation of the Earth, the distribution of land and sea, and some other more complex factors.

Atmospheric Pressure.—Air has a measurable weight or pressure. At sea level the pressure exerted by the air overhead is about 15 lbs. per square inch, and fluctuations in this pressure can be accurately measured by means of the barometer. For various reasons atmospheric pressure is measured, not in lbs. per square inch, but in “millibars”, and the scales of all modern barometers are graduated in these units. The average pressure at sea level is about 1013 millibars.

Three types of barometer are in general use, namely the “mercurial barometer”, the “aneroid barometer” and the “barograph”, which are described at the end of this chapter.

It has long been known that changes in atmospheric pressure are associated with changes of the weather, especially of the wind; hence the importance of keeping an accurate record of barometric readings. Broadly speaking, high pressure is associated with fair (though not always sunny) weather and light winds, while low pressure is usually accompanied by strong winds and rain.

Wind, and Beaufort Wind Scale

Wind is the result of a difference of pressure in two adjacent areas. The relationship between wind direction and the distribution of pressure can be expressed as follows:—

If you face the wind when in the northern hemisphere, pressure will be low on your right hand and high on your left, and in the southern hemisphere it will be low on your left and high on your right.

Wind is always named and recorded by the direction *from* which it is blowing reckoned from true North ; it should be logged to the nearest point of the compass. Its strength is estimated from the Beaufort scale given below and at the beginning of the *Ship's Log* ; the Beaufort scale force of the wind, and not the description should be entered in the log.

BEAUFORT WIND SCALE

WIND FORCE (Beaufort)	SPEED IN KNOTS	DESCRIPTIVE TERMS	COASTAL CRITERION	SEA CRITERION
0	Less than 1	Calm	—	Sea like a mirror.
1	1-3	Light Airs	Sufficient to give good steerage to fishing smacks with the "wind free".	Ripples with the appearance of scales are formed, but without foam crests.
2	4-6	Light breeze	Fishing smacks with topsails and light canvas "full and by" make up to 2 knots.	Small wavelets, still short but more pronounced; crests have a glassy appearance and do not break.
3	7-10	Gentle breeze	Smacks under topsails and light canvas begin to heel over slightly, and make up to 3 knots if "full and by".	Large wavelets, crests begin to break. Foam of glassy appearance. Perhaps scattered white horses.
4	11-16	Moderate breeze	Good working breeze. Smacks under all sail heel over considerably on a wind.	Small waves, becoming larger; fairly frequent white horses.
5	17-21	Fresh breeze	Smacks shorten sail.	Moderate waves, taking a more pronounced long form; many white horses are formed. (Chance of some spray.)
6	22-27	Strong breeze	Smacks double - reef gaff-mainsails.	Large waves begin to form; the white foam crests are more extensive everywhere. (Probably some spray.)
7	28-33	Moderate gale	Smacks remain in harbour, and those at sea lie to.	Sea heaps up and white foam from breaking waves begins to be blown in streaks along the direction of the wind. (Spindrift begins to be seen.)
8	34-40	Fresh gale	Smacks take shelter if possible.	Moderately high waves of greater length; edges of crests break into spindrift. The foam is blown in well marked streaks along the direction of the wind. Spray affects visibility.
9	41-47	Strong gale	—	High waves. Dense streaks of foam along the direction of the wind. Sea begins to roll. Visibility affected.
10	48-55	Whole gale	—	Very high waves with long overhanging crests. The resulting foam is in great patches and is blown in dense white streaks along the direction of the wind. On the whole the surface of the sea takes a white appearance. The rolling of the sea becomes heavy and shock-like. Visibility is affected.

BEAUFORT WIND SCALE—*cont.*

WIND FORCE (Beaufort)	SPEED IN KNOTS	DESCRIPTIVE TERMS	COASTAL CRITERION	SEA CRITERION
11	56-63	Storm	—	Exceptionally high waves (small and medium - sized ships might for a long time be lost to view behind the waves). The sea is completely covered with long white patches of foam lying along the direction of the wind. Everywhere the edges of the wave crests are blown into froth. Visibility affected.
12	64-71	Hurricane	—	The air is filled with foam and spray. Sea completely white with driving spray; visibility very seriously affected.
13	72-80	—	—	The above conditions become progressively worse.
14	81-89	—	—	
15	90-99	—	—	
16	100-108	—	—	
17	109-118	—	—	

When judging the force and direction of the wind at sea, due allowance must be made for the speed of the ship, and the direction of the wind must be obtained by looking at the waves and not at the funnel smoke, flag, or masthead pennant.

When the direction of the wind changes in a clockwise direction (*e.g.* from S.W. to W.) it is said to “veer”; when it changes in an anti-clockwise direction (*e.g.* from S.W. to S.) it is said to “back”.

Other Elements

TEMPERATURE

As already stated, the heat of the Sun is a primary cause of motion of the atmosphere. An important consequence is that the weather is intimately bound up with changes of temperature; the wind may blow warm or cold in ways with which we are all familiar.

Different substances require different amounts of heat to produce a given change in temperature. The amount of heat required to raise the temperature of water is two or three times greater than that required to raise the temperature of an equivalent volume of land by the same amount, and conversely, water yields from two to three times more heat than land when the temperature falls. The sea is therefore usually cooler than the adjacent land surfaces in summer or in hot regions, and warmer in winter or in cold regions.

Temperature is measured by means of a “thermometer”, which is described on page 734. At sea, both the temperature of the air and that of the sea surface are important, and different thermometers are provided for measuring each.

HUMIDITY

The amount of water vapour present in the air varies from place to place and from time to time, and is an important factor in determining the nature of the weather. The amount of water vapour that the air can hold in an invisible

state is limited, and it varies with the temperature. Warm air can hold more water vapour than cold air ; when the air contains as much water vapour as it can hold at a given temperature it is said to be saturated. If the temperature is lowered further, or more water vapour is added to the air, the surplus condenses into minute but visible drops of water, which constitute cloud, mist or fog.

Humidity is measured by means of a "hygrometer", the commonest form of which is the "wet and dry bulb thermometer", described on page 735. When the air is dry the wet bulb reading is several degrees below the dry bulb, but when it is saturated both will read the same and fog may then be expected.

CLOUD

As explained in the preceding paragraph, the cooling of air below its saturation point results in the condensation of the surplus water vapour into visible droplets of water. Such condensation occurring in the atmosphere results in the formation of cloud, and it is largely upon the method of cooling that the type of cloud depends.

Air is often heated in its lower layers by its passage over a relatively warm land or sea surface. This causes it to expand, become lighter, and rise (in the same way that warm water rises in the hot water system of a house). As the air rises it expands further due to the decrease in pressure, and cools due to its expansion. If this cooling is continued beyond the point at which the air is saturated, cloud results. Clouds formed in this way are of the "cumulus" type, with flat horizontal bases, and rounded "cauliflower" heads which sometimes spread at great heights into the shape of an anvil.

Where two masses of air from different sources and with different characteristics meet, boundary lines are formed where the colder and heavier air runs under the warmer and lighter air and compels it to rise. As in the previous case, the expansion and cooling of this air results in the formation of cloud, which spreads as a more or less shapeless layer of "stratiform" cloud.

Air may also be forced to rise up the sides of mountains and high ground towards which the wind is blowing. The consequent expansion and cooling of the air again results in the formation of stratus type cloud if the ascent of the air is sufficient to cause condensation.

RAIN, SNOW, AND HAIL

If the cooling process which gives rise to cloud formation is continued the droplets of which the cloud consists grow in size until they become too heavy to be borne aloft by the ascending air, and they therefore fall to the ground as very fine rain or drizzle. If the upward currents of air are strong enough they will fall as raindrops. When very strong up-draughts exist, as in large cumulus type clouds, the drops become very large before falling as heavy showers of rain, or, under certain conditions, as hail. The latter is caused by very strong up-draughts carrying the raindrops above the freezing level, where they turn into continually growing balls of ice which eventually fall to the ground as hailstones. Thunderstorms are often accompanied by hail because they also are caused by very strong up-draughts extending to great heights.

If the temperature at which condensation actually takes place is below freezing point the droplets form as ice crystals, which grow and become snowflakes. Snowflakes often melt and change to raindrops before reaching the ground ; as a rough guide, snow rather than rain is likely if the air temperature at ground or sea level is below 37° F.

FOG AND MIST

The cause of fog and mist is fundamentally the same as that of cloud, *i.e.* the cooling of air below the temperature at which it can contain its water vapour in an invisible state. In cloud the resulting condensation into visible particles takes place aloft, but in fog or mist the condensation occurs on the surface of the sea or ground. The difference between fog and mist is merely one of degree, visibility of under 1,100 yards (approximately 5 cables) constitutes a fog, and mist is recorded when the visibility is between 1,100 yards and 2,200 yards (*i.e.* from half a mile to one mile approximately).

In the open sea almost every fog is caused by warm, moist air blowing over a relatively cold sea surface, whereby the lower layers of the air are chilled and fog is formed. These sea fogs are therefore most common in spring and early summer, at which seasons the sea surface temperature is lowest. They are also particularly prevalent in the vicinity of cold ocean currents.

Over the land, on clear nights with little wind, a sharp drop in temperature occurs after sunset due to the earth radiating its heat away into space. The air in contact with the ground is cooled, condensation takes place and fog is formed. Such land-formed fogs are known as "radiation fogs", and are most common in the winter with its long nights; they are thickest in the latter part of the night and early morning. As the earth becomes heated during the day such fogs become thinner and often disperse. They frequently affect harbours, especially in smoky industrial areas, and may drift seaward under the influence of offshore winds, thus giving rise to coastal fog. If the sky is cloudy, fogs of this type are improbable because the clouds act as a blanket and to a large extent prevent the earth losing heat by radiation; neither do they occur with strong winds, which thoroughly stir the air and so prevent any of it remaining long enough in contact with the cold ground.

As fog can only occur when the air is saturated, or very nearly so, the wet and dry bulb thermometer (or hygrometer), provides a useful guide as to its probability.

Pressure Systems

The relationship between pressure distribution and wind direction has already been explained on page 716. From this relationship it follows that in the northern hemisphere the wind circulates around an area of low pressure in an anti-clockwise direction, and in the southern hemisphere in a clockwise direction. These areas of low pressure are known as "depressions" or "lows", and they are generally associated with cloudy unsettled weather and strong winds. Depressions usually move fairly quickly, and almost always from a westerly towards some easterly point. In the northern hemisphere the approach of such a system is therefore heralded by the wind backing towards a southerly point, and in the southern hemisphere by the wind veering towards a northerly point. Its approach is also foreshadowed by a falling barometer, an increase and thickening of cloud, and later, by rain.

It also follows from this relationship that the circulation around an area of high pressure is clockwise in the northern hemisphere, and anti-clockwise in the southern hemisphere. Such an area of high pressure is known as an "anti-cyclone" or "high". Like depressions, anti-cyclones generally move in an easterly direction, but in the eastern parts of the oceans the movement is usually slow and erratic, and an anti-cyclone may remain nearly stationary for

days at a time ; consequently the weather often remains much the same for considerable periods, and then changes slowly. Anti-cyclonic weather is often fine and sunny, though at times overcast and gloomy weather prevails ; winds, however, are only light or moderate in strength, and rain is unlikely ; radiation fog often forms over the land at night and affects harbours and coastal areas, and in winter it may persist throughout the day.

Local Forecasting

A short-range forecast of changes in the weather can often be made by intelligent observation of wind, cloud and sky, and of the movements and readings of the barometer. Local weather lore is also of assistance, though it must be remembered that not even the best known and most reliable saying about the weather is infallible ; no saying based upon the phases of the moon has any meteorological significance whatsoever. It must also be remembered that local weather lore applies to the locality of origin, and cannot be applied indiscriminately elsewhere. The following indications, when taken in conjunction with such other evidence as may be available, should help an isolated observer to forecast the weather for the next few hours, *in the eastern North Atlantic*.

BAROMETER

The average barometer reading in the south of England is about 1014 millibars, and in the north of Scotland it varies from about 1013 millibars in summer to 1008 millibars in winter ; the following table shows the probable weather to be expected for different departures from these normals.

Barometer 5 Mb. or more below normal, and steady or falling ;	unsettled.
Barometer 5 Mb. or more above the normal, and steady or rising ;	settled for at least a day with light or moderate winds.
Barometer below 1000 Mb. or falling rapidly at 1 Mb. or more in an hour ;	strong winds and rain.
Barometer rising rapidly ;	fair or fine, usually followed in a day or so by another fall and more unsettled weather.
<i>Long foretold long past Short notice soon past ;</i>	indicating that a steady fall over a long period foretells a long spell of bad weather ; but a rapid fall indicates a short but severe spell.
<i>First rise after low Foretells a stronger blow ;</i>	indicating that the full force of a gale is often felt after the centre of a depression has passed. Gales with a rising barometer are always squally.

WIND

In the absence of a weather map the relationship between wind direction and weather in Home waters and the north-eastern Atlantic is not well defined, but it is possible very broadly to distinguish the following four main types :—

South-westerly winds.—These come from the warmer waters of the Atlantic further southward and are cooled at the surface by the progressively decreasing sea temperatures as they travel towards us. Weather is mild and damp with poor visibility, and skies are nearly or quite overcast with a pall of low cloud. Drizzle is common on outlying coasts, and weather is generally unsettled with the probability of rain. In late spring and early summer sea fog may occur.

North-westerly winds.—These bring cold air from higher latitudes which is warmed at the surface during its passage over progressively warmer water. Weather is cool or cold with good visibility, and clouds of the cumulus type are formed from which showers fall. In winter the showers may be of snow.

North-easterly winds.—These have usually come from Scandinavia or north Russia. Weather is cool in summer and cold in winter. Skies are most often cloudy or overcast, and snow is common in the winter.

South-easterly winds.—These have usually come from central Europe, and are cold and dry in winter, and warm and dry in summer. Cloud amounts are generally small.

The following sayings originated in the days of sail, long before weather forecasting became a science, but they are well worth remembering; they apply of course only to Home waters and the north-eastern part of the Atlantic.

A veering wind—fair weather

A backing wind—foul weather

A wind backing towards a southerly point is often an early sign of an approaching depression; a veering wind indicates that the "low" is passing away eastward and that improving weather will be experienced.

*If the wind is NE, three days
without rain;*

*Eight days will pass before South
wind again*

One of the most striking features about weather in these latitudes is the tendency for a given type—good or bad—to persist once it has become established. This tendency is recognised in these sayings.

*When the rain's before the wind,
Topsail halliards you must mind;
When the wind's before the rain,
Hoist your topsails up again*

With an approaching depression, if there is little wind when the rain starts, it will probably blow hard before long, whereas if the gale comes first it will probably have done its worst by the time the rain comes.

SKY

A low sunset—fair weather

A high sunset—rain and/or wind

A sunset is low when the Sun sets on a clear horizon; a sunset is high when it sets behind a bank of cloud well above the horizon. Bad weather usually approaches from westward and is preceded by a bank of cloud which hides the sunset.

Grey sky in the morning	Fine weather.
Bright yellow sunset	Wind.
Pale yellow sunset	Rain.
Red sunset	Fair weather.
Dark blue sky	Wind.
Light blue sky	Fine weather.

CLOUDS

Soft-looking delicate clouds	Fine weather with light or moderate breezes.
Hard-edged, oily-looking clouds	Wind.
Small, inky-looking clouds	Rain.

After fine, clear weather the first signs in the sky of a coming change are usually light streaks, curls, or wisps of distant white cloud, which increase until the sky takes on a milky appearance and the Sun and Moon become surrounded by haloes. The cloud thickens until the Sun and Moon are seen only indistinctly through a watery sky, which foretells rain within a few hours. These are infallible signs of an approaching depression, but often they cannot be seen because the sky is covered with lower clouds.

Misty clouds forming or hanging on heights	If they remain, there will be wind and rain ; if they rise or disperse, the weather will improve or become fine.
--	--

GENERAL

When sea birds fly out early and far to seaward	Fair weather and light or moderate winds.
When sea birds remain over land or fly inland	Stormy weather.
Dew and fog forming inland at night	Fine weather ; neither dew nor fog form under an overcast sky, nor when there is much wind.

Climate

" Climate " may be defined as being the average condition of the atmosphere taken over a long period, and is largely dependent on the average condition of the wind, weather and temperature ; " weather ", on the other hand, comprises the state of these elements at any given time. In temperate and high latitudes, variations from the average are large, and consequently average conditions are not a good guide to the conditions likely to be experienced on any given day. In the tropics, however, such variations are much smaller, and averages give a truer picture of the actual weather conditions likely to be experienced.

Climate is governed largely by the average distribution of barometric pressure over the surface of the earth, and by the greater amount of heat received from the Sun in low latitudes than in high latitudes. Fig. 410 shows diagrammatically what would be the normal distribution of pressure over the Earth were it entirely covered by water, together with the resulting winds and the names long given by seamen to the various regions.

The zones shown in Fig. 410 oscillate according the seasons ; they reach their most northerly position in about July or August, and their most southerly in

January or February. The amount of oscillation generally averages only some 5 degrees of latitude.

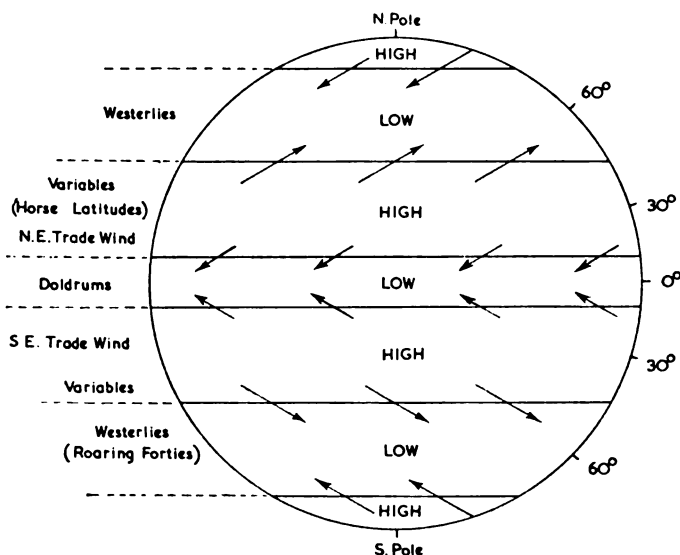


Fig. 410. Climatic zones

Effects of the distribution of land and sea.—The effect of large land masses is considerably to modify the simple zonal distribution of pressure and wind shown in Fig. 410. The belts of high pressure in latitudes about 30° N. and S. are split up into separate cells of high pressure (or anti-cyclones) situated over the eastern part of each ocean. The belt of low pressure in latitude about 60° N. is likewise modified into separate areas of low pressure situated in the vicinity of Iceland and the Aleutian islands; these areas of low pressure are actually the result of the numerous depressions which travel eastward across the north Atlantic and North Pacific oceans in the zone of the Westerlies (see page 725). In the southern hemisphere there is little land in the area covered by this low pressure belt, which consequently extends uninterruptedly around the Earth.

Superimposed on these modifications of the simple zonal distribution of pressure is a tendency for pressure over land masses to become relatively high in winter, and low in summer. This seasonal change in pressure distribution causes a corresponding modification of the oceanic winds in the vicinity, and results in the establishment of seasonal winds such as Monsoons, which are described below. Figs. 411 and 412 show the normal distribution of wind over the oceans in January to March, and in July to September, respectively.

Oceanic Winds

The areas covered by the various oceanic winds are best seen from a study of Figs. 411 and 412, and the following remarks on the areas concerned serve to amplify these wind charts.

DOLDRUMS

That part of the ocean lying in the equatorial trough of low pressure situated between the Trade Winds of the two hemispheres is known as "the Doldrums".

The characteristic features of this zone are calms and light variable winds alternating with squalls, heavy rains and thunderstorms. Apart from the above short-lived squalls, or in association with tropical storms which are described below, gales do not occur in this zone.

TRADE WINDS

The main feature of the North-east and South-east Trades is their steadiness and persistence. They blow permanently throughout the year and vary but little in direction. Their average strength is about force 3-4 Beaufort scale, though at times they may freshen to force 5 or 6, and at others lull to force 1. Apart from occasional squalls, winds of gale force are rare and when they occur are usually associated with tropical storms (see below). It should be noted that the Trade winds do not blow in the northern part of the Indian Ocean, or the western part of the North Pacific, in which areas their place is taken by the Monsoons which are described below.

VARIABLES

Between the polar limits of the Trade winds and the equatorial limits of the Westerlies, there exists a belt of variable and mainly light or moderate winds known as "the Variables" in the "Horse latitudes". The approximate areas they cover are indicated in Figs. 411 and 412; towards the equator they merge into the prevailing Westerlies of higher latitudes.

WESTERLIES

On the polar side of the Variables mentioned above, westerly winds prevail. These westerly winds, however, are not permanent in the same way as are the Trade winds; although *prevailingly* westerly in direction the constant passage of depressions across this zone causes much variation in both the direction and force of the wind, and on individual days winds from any direction may be experienced. Gales are common, especially in the winter months, and in the southern oceans their high frequency south of about latitude 40° S. has earned for this region the name of the "Roaring Forties".

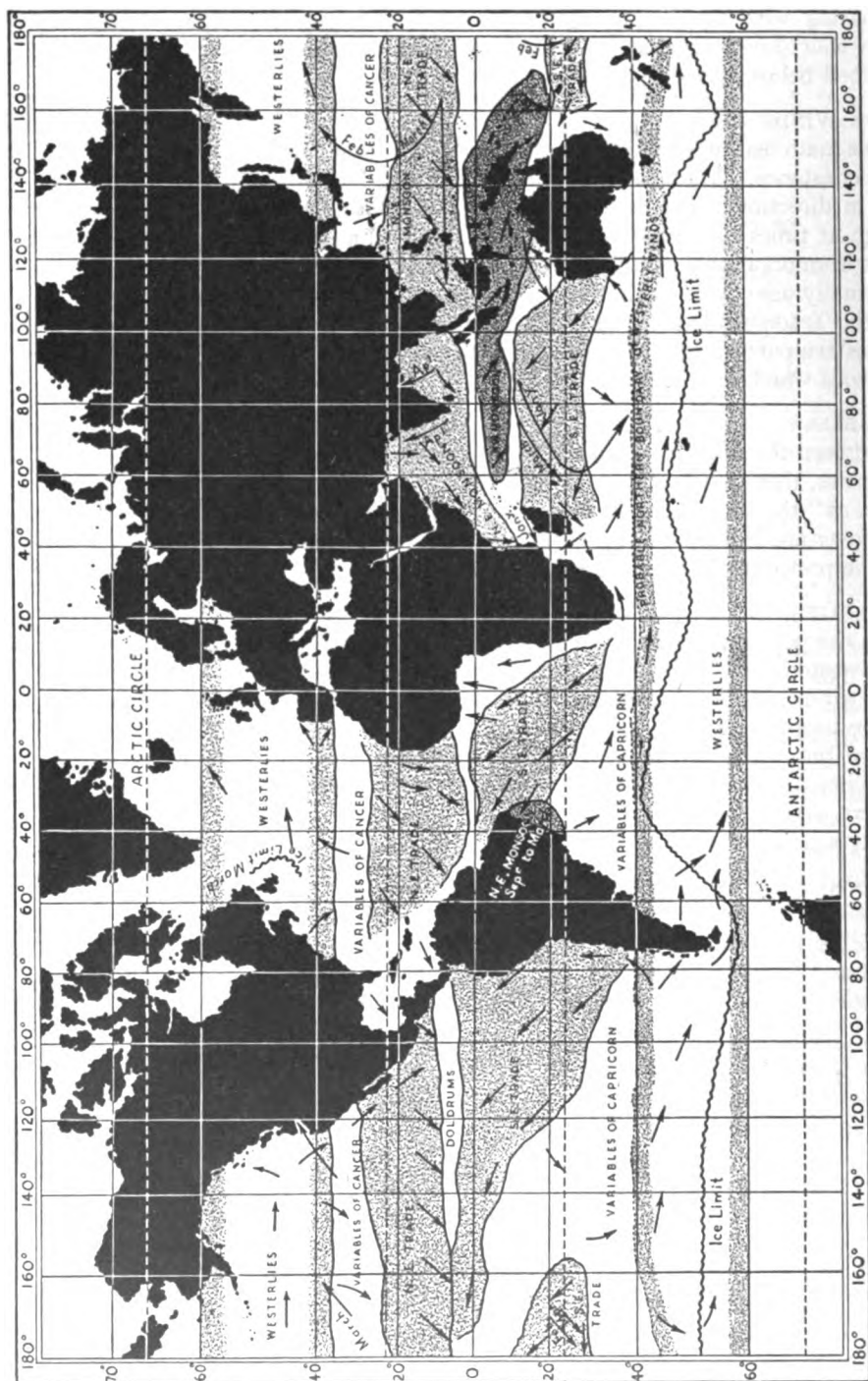
MONSOONS

These are seasonal winds caused by the summer heating and winter cooling of large land masses. The most important of these seasonal winds occur in the Indian and Western Pacific Oceans, and are the result of the alternate heating and cooling of the vast Asiatic continent.

The South-west Monsoon (Fig. 412) prevails over the whole of the northern Indian Ocean, and western North Pacific, from about May or June to September. Over the greater part of the northern Indian Ocean the strength of the Monsoon is moderate or fresh, but in the western part of the Arabian Sea it blows strongly and frequently reaches gale force; in the China Seas and western North Pacific it is only light and often rather variable in direction.

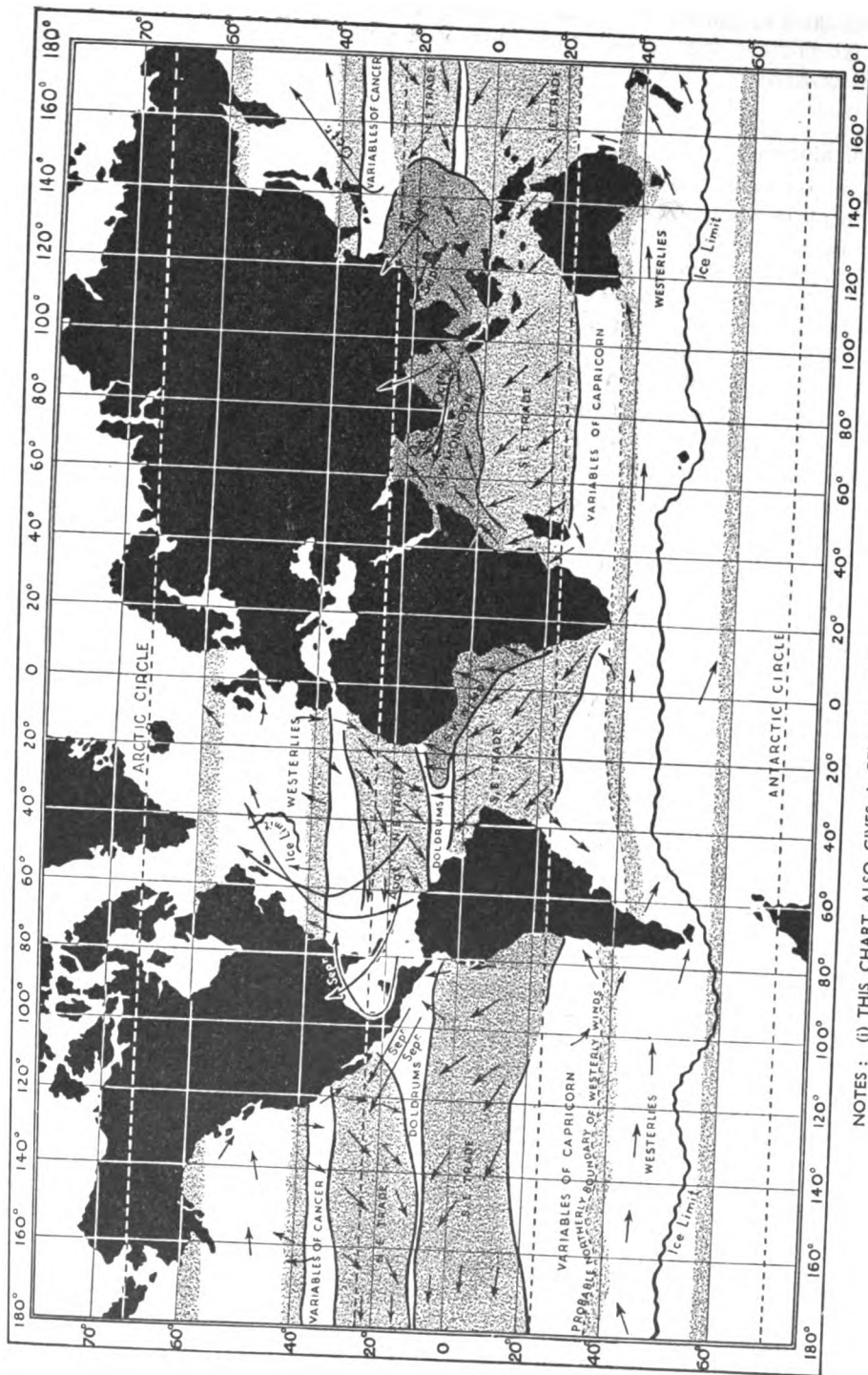
The North-east Monsoon (Fig. 411) prevails over the Northern Indian Ocean, and western North Pacific, from about October to March or April. In the northern part of the China Sea it blows freshly or strongly reaching gale force at times, but in the northern Indian Ocean it is usually only light or moderate in strength.

The North-west Monsoon (Fig. 411) blows in the northern part of the southern Indian Ocean and western South Pacific oceans, and results from the North-east Monsoon crossing the equator into the southern hemisphere, where the



NOTES : (i) THIS CHART ALSO GIVES A GENERAL IDEA OF THE WINDS WHICH MAY BE EXPECTED
 BETWEEN NOVEMBER AND APRIL
 (ii) TRACKS OF STORM CENTRES BETWEEN JANUARY AND APRIL ARE SHOWN THUS —→
 WITH THE MONTH IN WHICH THEY WERE OBSERVED

Fig 411. Wind char of the world for January, February and March



NOTES: (i) THIS CHART ALSO GIVES A GENERAL IDEA OF THE WINDS WHICH MAY BE EXPECTED BETWEEN MAY AND OCTOBER
 (ii) TRACKS OF STORM CENTRES BETWEEN JULY AND NOVEMBER ARE SHOWN THUS —→ WITH THE MONTH IN WHICH THEY WERE OBSERVED

Fig. 412. Wind chart of the world for July, August and September

reversed effect of the Earth's rotation causes it to be felt as a north-westerly wind. It prevails from about November or December to March, the area covered being shown in Fig. 411.

Tropical Storms

These storms are a serious menace in tropical and sub-tropical latitudes, and occur in all oceans except the South Atlantic. They are rarely encountered within about 8 degrees of the equator, and never in its immediate vicinity. They consist of relatively small but very intense depressions, around which the wind circulates in the normal direction for the hemisphere concerned and often reaches hurricane strength. The very high winds experienced in the storm are a cause of extremely heavy seas, while torrential rain and driving spray reduce visibility to almost nothing.

These storms are known by different names according to the part of the world in which they occur, a list of which is given below.

Western North Atlantic	... hurricanes.
Arabian Sea and Bay of Bengal	... cyclones
South Indian Ocean	... cyclones.
North-west Australia and vicinity	... willy-willies.
Western North Pacific	... typhoons.
Eastern North Pacific	... hurricanes.
Western South Pacific	... hurricanes.

Seasons, and signs of approach.—In the northern hemisphere nearly all tropical storms occur between June and mid-November, and in the southern hemisphere they are unlikely except between mid-December and early May. The months of maximum frequency are usually August and September in the northern hemisphere, and February and March in the southern hemisphere. In the Arabian Sea, however, storms are most likely at the change of the Monsoon, *i.e.* in May and June, and in October and November.

Warning signs of the approach of a tropical storm are given in all volumes of the *Admiralty Sailing Directions*, and mention here is made only of the necessity for keeping a careful watch on the barometer reading in the areas, and during the seasons, in which they occur. In the tropics the barometer reading varies little, apart from a regular diurnal oscillation which is ready visible on the barograph trace. Provided that the ship has remained in the same locality, a reading of 5 Mb. or more below the average *at that time* for the last two or three days should be regarded with suspicion, as it is probable that there is a tropical storm within 300 miles or so.

Local Winds

In the vicinity of the coast, and thus in harbours, the wind experienced is often very different from that blowing over the adjacent ocean. It is not possible here to go fully into these many local effects, but two of the most important are described below.

Sea and Land Breezes.—These regularly alternating winds are a conspicuous feature of nearly all tropical coasts and islands (other than very small islands), and they occur also in temperate latitudes in fine settled weather in the summer.

They are caused by the daily, unequal heating and cooling of land and water by radiation. By day the land and the air over it rapidly acquire heat from the Sun's rays, but the sea does not ; the heated air over the land therefore expands and rises, and the cooler air over the sea flows in to take its place and results in an onshore wind known as the " sea breeze ". This sea breeze generally starts at about 1100 local time, reaches its maximum strength (usually about force 3) at about 1400, and dies away at sunset. By night the rapid cooling of the land, and consequently of the air in contact with it, results in the cooled, dense, air flowing offshore as the " land breeze " to take the place of the then warmer air rising from the sea. In most places the land breeze is much weaker and less evident than the sea breeze, because by day the difference in temperature of the land and sea is considerable, but at night it is very little ; it usually starts during the first watch and blows until about sunrise.

Eddies and Squalls.—In confined harbours backed by high ground, or close to mountainous coasts, winds are often fluky and conflicting. Offshore winds in such localities, if at all strong, are likely to be accompanied by severe squalls which are dangerous to boats and small craft and may cause ships to drag their anchors. Their likelihood should be borne in mind when taking shelter under the lee of high land, and especially off the entrances to narrow valleys, where they often occur.

Climatic Zones

The climate of any place depends upon a large number of inter-related factors. These include not only the most obvious one of latitude, but also the direction of the prevailing winds and whether they reach the area under consideration after a long passage over the sea or the land, and the degree of exposure to, or shelter from, such winds due to local topography. Considerable variations of climate may thus be found even between closely adjacent areas, and no very simple picture of world climate can therefore be drawn. It is possible, however, to distinguish very broadly the following climatic zones, though the limits of latitude given must be regarded as very approximate and it must be remembered that each zone merges gradually into that adjacent to it.

EQUATORIAL ZONE (within 3 or 4 degrees of the equator)

In this zone seasons are practically non-existent. Temperature is uniformly high throughout the year, and rainfall (usually in the form of heavy showers) is abundant in all months. Winds, apart from thundery squalls, are light and variable, and land and sea breezes are experienced close off the coast. Fog is almost unknown except in the early morning over low-lying damp places ashore.

TROPICAL ZONE (latitude 4°–15° North and South)

The main feature of this zone is the alternation of the wet season, which occurs in the summer of the hemisphere concerned, with the dry season which occurs in the winter and during which little or no rain falls and there is much sunshine. Over Asia this zone extends further north and includes the whole of India and Burma. Temperature is generally highest immediately before the start of the rainy season.

DRY ZONE (latitude 15°–30° North and South)

This zone is really only " dry " on the eastern side of the oceans it embraces. It is nevertheless in this belt that most of the major deserts of the world are found, *i.e.* the Sahara and Kalahari deserts in North and South Africa, the

Arabian desert in Asia, the great Australian desert, and the dry zones of the western parts of North and South America. On the eastern side of the oceans, too, this zone has much sunshine and very little rainfall. Here the Trade winds usually prevail; temperatures are comparatively low for the latitude owing to cold ocean currents flowing along the coast, and poor visibility occurs fairly frequently owing to the coldness of these currents, and sometimes to sand and dust being carried seaward by the prevailing offshore wind.

In similar latitudes on the western side of the ocean, rain is experienced in all months and is heaviest in the summer. Fog is rare, and temperatures are fairly high except for three or four months during the winter.

SUB-TROPICAL ZONE (latitude 30°–40° North and South)

On the eastern side of the oceans (*e.g.* in the Mediterranean and off Cape-town, California, and S.W. Australia) the summer is hot and dry, and the winter is mild and rather rainy owing to moving depressions, which also bring strong winds and gales. Even in winter, however, there are often fine sunny periods.

On the western side of the North Atlantic and North Pacific oceans this belt is, for its latitude, often very cold in winter and very warm in summer; the winter cold is largely due to the prevailing offshore north-westerly or northerly winds, and the summer heat to southerly onshore winds. In winter, gales are frequent in the central and western parts of these oceans, but in summer, conditions are usually quiet. In the southern hemisphere the winter in this zone is never particularly cold owing to the absence of any sufficiently large continental land mass.

TEMPERATE ZONE (latitude 40°–65° North and South)

The most conspicuous feature of the weather in this zone is its great variability; nearly all the weather elements are liable to show sharp contrasts from one day to another. Owing to depressions constantly travelling through this region, fine weather is seldom prolonged and gales are frequent, especially in winter.

In winter, on the western side of the North Atlantic and North Pacific oceans it is very cold with prevailingly north-westerly winds, but on the eastern side the prevailing south-westerly winds maintain mild weather, which is broken only occasionally by an outburst of cold weather when the wind temporarily becomes easterly or northerly in origin.

In summer on the western side of these oceans, the prevalence of southerly winds blowing over the cold currents which flow there result in a very high frequency of sea fog.

Elsewhere in the open seas of this zone sea fog is most likely in the late spring and early summer, though in harbour and close to the coast the incidence of fog formed by land radiation makes fog most frequent in winter months.

It is in this zone particularly that climatic averages are apt to be most misleading, and day-to-day forecasting is the only method of obtaining satisfactory advice on the future weather.

METEOROLOGICAL INSTRUMENTS

It is most important that the readings of the various instruments provided should be taken accurately and at the times laid down. Inaccurate or unpunctual observations may lead to false conclusions being drawn regarding the weather to be expected, both on board and in any meteorological centre to which the readings are transmitted.

Mercurial Barometer

Basically this instrument consists merely of a glass tube closed at one end and filled with mercury. The tube is inverted and its open end placed below the level of the surface of the mercury in a small cistern; the mercury in the tube then descends until the weight of the column is balanced by the pressure of the atmosphere on the mercury in the cistern, thus affording a measure of

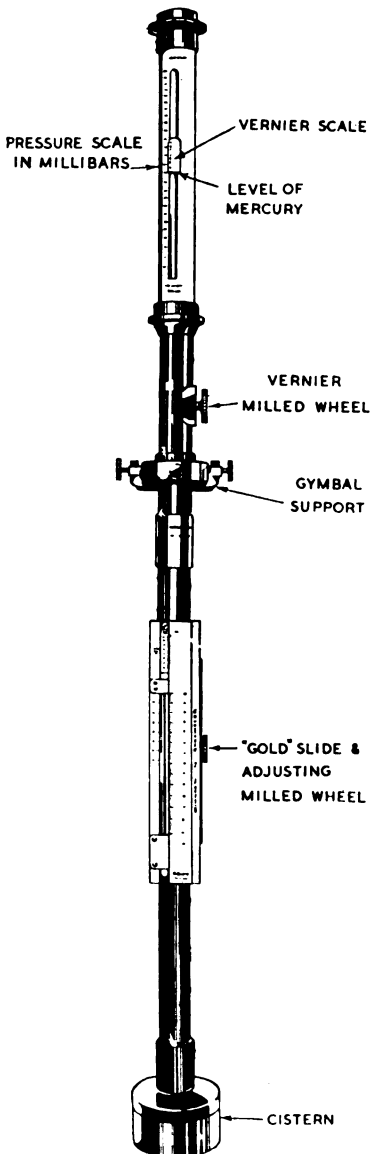


Fig. 413. A Mercurial barometer

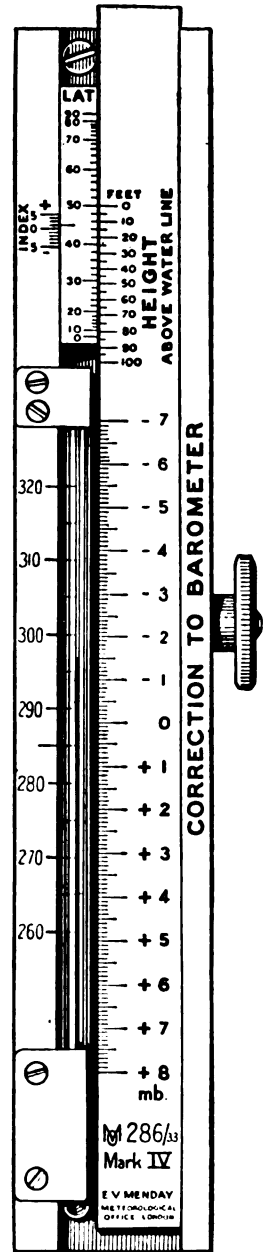


Fig. 414. The "Gold" slide

that pressure. By means of a scale whose zero is level with the surface of the mercury in the cistern the exact height of the column can be read.

Great care should be exercised in handling a mercurial barometer. Suddenly to lower the top usually results in breaking the tube owing to the vacuum at its top permitting the mercury column to act as though it were a solid metal rod. It is advisable to unship the barometer before carrying out full-calibre firing from the main armament, unless it is kept low down in the ship and well protected from shock. When unshipped the barometer should be tilted slowly to an angle of about 45° and be held in this position until the mercury has crept up the tube and completely filled it. It should then be inverted very slowly and stowed with the cistern end uppermost.

THE GOLD SLIDE

The height of the mercury in the barometer is to a certain extent affected by its height above sea level, the latitude of the ship, and the temperature of the atmosphere, and to obtain the true atmospheric pressure the actual reading of the barometer must therefore be corrected. The necessary correction is obtained from a sliding scale clamped to the lower half of the barometer and known as the "Gold Slide" (see Fig. 413).

The Gold Slide incorporates a thermometer graduated in degrees "absolute", a scale of latitude, and a sliding scale graduated in millibars (see Fig. 414). The sliding scale is usually set, by the Navigating Officer or the Chief Quartermaster, for the height of the barometer above sea level and the ship's latitude, and it should be altered only when the latitude of the ship is appreciably changed.

HOW TO READ THE BAROMETER

The Correction from the Gold Slide must be obtained first, because the proximity of the observer may affect the height of the absolute thermometer and so lead to an incorrect reading. The necessary correction is either added to, or subtracted from, the actual reading of the barometer, and it is read off the millibar scale of the Gold Slide in units and tenths (plus or minus) against the height of the thermometer (in Fig. 414 it is -1.5 millibars).

The height of the mercury in the barometer should now be read in the following manner, great care being taken to keep the eye exactly level with the top of the curve of the mercury (see Fig. 415).

Turn the milled wheel of the "vernier" scale until the lower edge of the vernier is level with the top of the mercury, then :—

- (i) note the scale line next below the level of the top of the mercury column, as shown by the left-hand lower edge of the vernier (in Fig. 415 this is 1028);
- (ii) look at the vernier and note which of its lines is exactly in line with a line on the scale (in Fig. 415 this is the line marked "3", and represents 0.3 of a millibar);

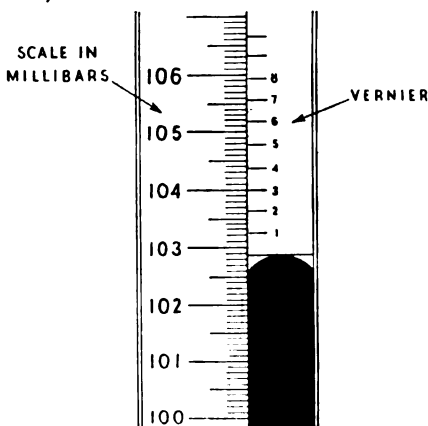


Fig. 415. Reading height of mercury

- (iii) add the two together to obtain the *uncorrected* reading of the barometer (in the example given in Fig. 415 this is $1028 + 0.3 = 1028.3$ millibars).

The correction previously obtained from the Gold Slide should now be applied to this uncorrected reading to obtain the *true reading* of the barometer, (in the examples given in Figs. 414 and 415 the true reading is thus $1028.3 - 1.5 = 1026.8$ millibars).

Aneroid Barometer

This depends for its indications on the very slight movements of the top of a disc-shaped metal box. The box is made of very thin corrugated metal and is partially exhausted of air, which makes it very susceptible to the slightest change in external pressure. The slightest movement of the top of the box is transmitted by a system of magnifying levers to a pointer, which moves over a graduated dial.

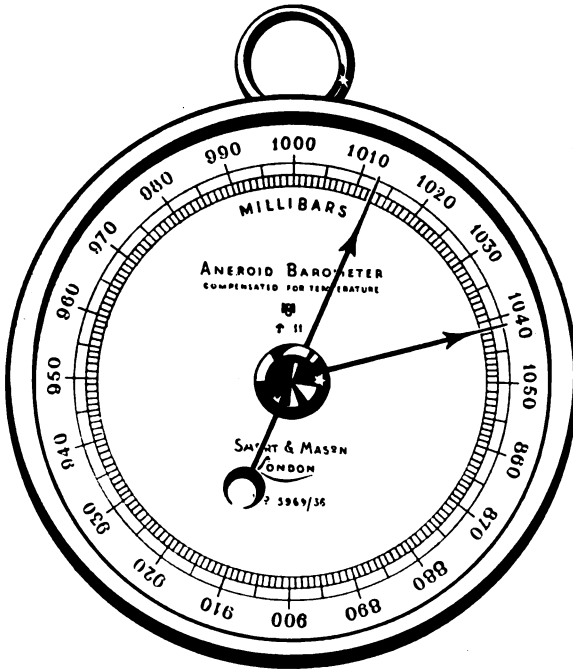


Fig. 416. An aneroid barometer

Aneroid barometers are liable to get out of adjustment, and the instrument should therefore be checked frequently with a mercurial barometer. If the instrument is shifted to a new position at a different height it will require readjusting. The aneroid box is delicate and can easily be strained if adjustments are not carried out correctly, as described in the *Admiralty Manual of Navigation*. An aneroid should be tapped very gently before it is read.

Barograph

This is a type of aneroid in which the pointer is replaced by a pen which records on a rotating clockwork drum the movements of a corrugated cylinder known as the "bellows". The drum makes one revolution in seven days, and the charts provided are graduated to indicate the day of the week and the time as well as the atmospheric pressure in millibars. This instrument is useful in that it provides a continuous record of atmospheric pressure; it also enables an observer to detect casual errors in the reading of the mercurial barometer, and registers minor fluctuations of pressure which would seldom be noticeable in the action of the mercurial barometer.

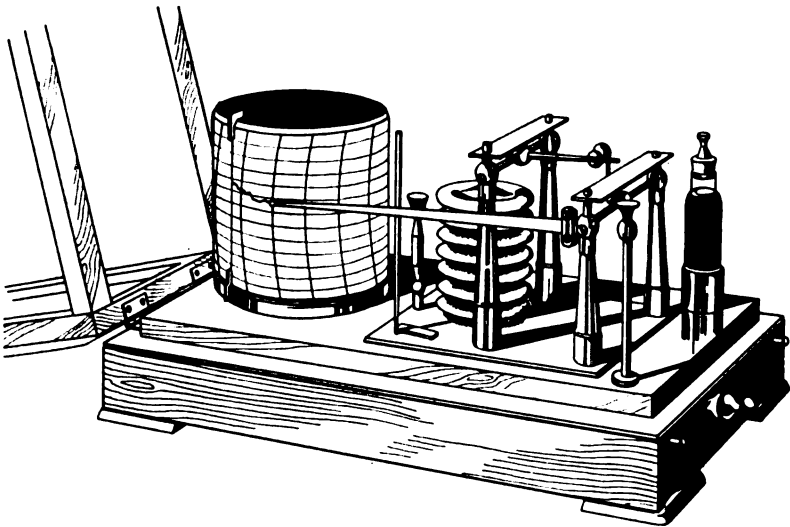


Fig. 417. A barograph

The barograph should be placed in a position where it is least likely to be affected by vibration, concussion and gusty draughts of air, and should be secured in an athwartships position so that the pen does not leave the paper when the ship is rolling.

Means are provided for adjustment, and the same precautions should be observed as with the aneroid barometer.

Thermometer

This consists of a closed glass tube of fine bore terminating in a bulb at one end. The bulb and part of the tube contain mercury, which expands and contracts under the influence of varying temperatures. A graduated scale is provided on which the temperature is read.

For meteorological purposes the temperature of both the air and the sea surface are required. The air temperature is obtained by means of the dry bulb thermometer of the hygrometer, which is described below. The

thermometer used for measuring sea temperature is fixed in a metal case as a protection against breakage, and is lowered over the side in a special canvas bucket fitted with a lanyard (see Fig. 418). To take the sea temperature, place the thermometer in the bucket, reeve the lanyard through the ring of the thermometer, and lower the bucket over the side until it is just immersed. Leave it in the water for about a minute, then haul it aboard and read the temperature. The bucket should be lowered in water which is well clear of the ship's discharge pipes and as near the bows as possible.

As it is the *surface* temperature that is required, temperatures obtained from the thermometer in the engine-room circulator-intake should not be used, unless it is impossible owing to weather conditions to obtain the temperature of the surface water as described above.

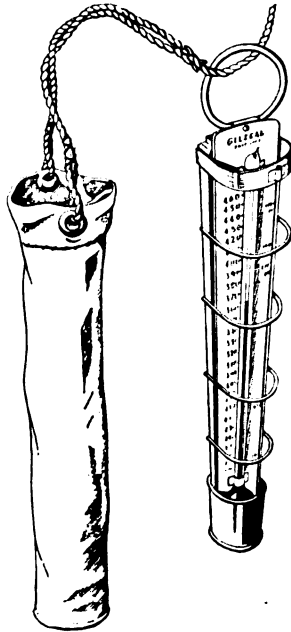


Fig. 418. A sea thermometer with its bucket

Hygrometer (Fig. 419)

This instrument is for measuring the humidity of the air. It consists of two thermometers, called respectively the "wet" and "dry bulbs", kept in a box known as the "Stevenson screen". One thermometer registers the temperature of the air; the other has its bulb surrounded by a piece of muslin which is kept moist by a wick connecting it with a small pot of distilled water. Evaporation from the muslin lowers the temperature of the wet bulb, which consequently reads lower than the dry. The drier the air the greater is the rate of evaporation, and the greater will be the difference between the wet and dry bulb readings; consequently, the readings of the wet and dry bulb thermometers provide a measure of the humidity of the air.

The screen must not be bolted to a bulkhead; it should be moved around as necessary to expose it on the windward side to air coming in over the ship's

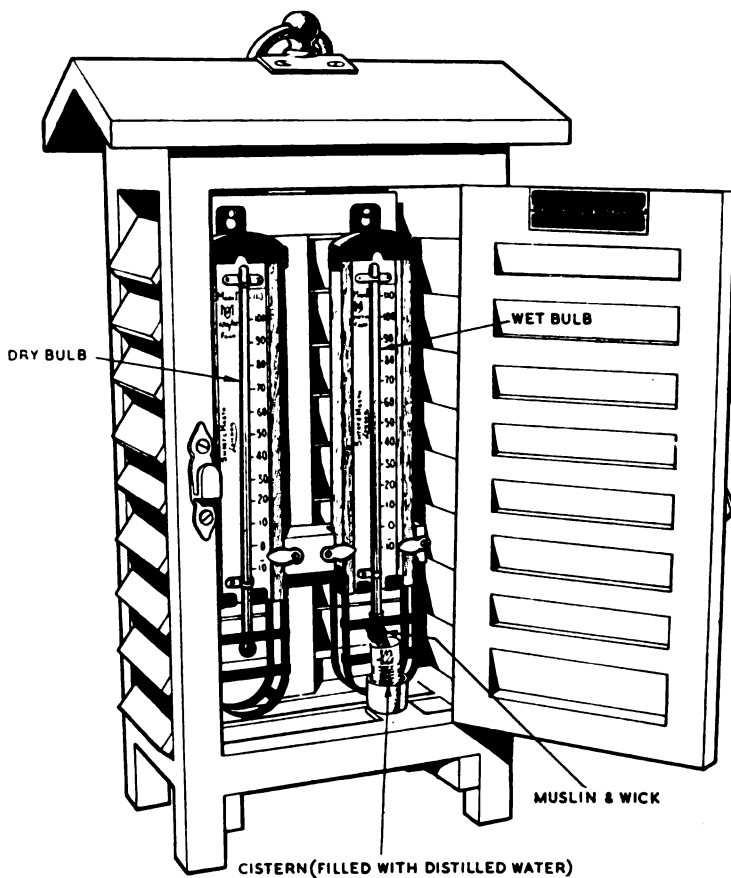


Fig. 419. A hygrometer in a Stevenson screen

side clear of the effects of local heating. It is essential that the pot of water be kept topped up with distilled water, and that the dry bulb be kept clean and free of the encrusted salt which easily collects on it at sea. The muslin and wick should be changed and the pot be washed out and refilled with distilled water at frequent intervals; in addition this should always be done after experiencing heavy weather.

If the wet bulb becomes frozen its readings are still valid provided it is coated with ice. Ultimately, however, the coating of ice will entirely evaporate and so the muslin must be wetted by means of a small brush or feather; a new film of ice will then form, and the wet bulb should be read when its reading has become steady.

APPENDIX I

GLOSSARY

Terms and expressions which have been explained in the text of this manual are not included here unless they have other meanings or interpretations. Slang terms and proper terms with a slang version, are printed in *italics*. References to terms not included in this glossary may be found in the index of this volume, or in the indexes of Volumes I and III.

- A.1.—first class, the best. The highest classification at Lloyds of a vessel's seaworthiness (the letter refers to the hull and the number to the equipment).
- A.B.—able-bodied seaman. It denotes a man who is technically qualified and fit to carry out a seaman's duties, both aloft and on deck.
- Adrift*—absent, late for muster or an appointment.
- AHOY !—the seaman's hail to call attention.
- All at sea*—confused, at a loss.
- ALL STANDING—to bring up any thing or person all standing is to bring it or him to a sudden and unexpected stop.
- AMAIN—suddenly.
- Andrew Miller, or the Andrew*—the Royal Navy. (Andrew Miller was a zealous press-gang officer who impressed so many men into the King's Naval Service during the Napoleonic wars that he was said to own the Royal Navy.)
- A's AND A's—alterations and additions to the structure, rigging and equipment of a warship.
- ARISINGS—pieces of material or metal left over from a job which are of value. They are collected and may be sold, melted, or made up again.
- ATHWART—across, as in "athwart the hawse", "athwart the tide", "athwart the wind".
- ATOLL—one or more low lying coral islands surrounding a lagoon (see "lagoon")
- AWASH—level with the surface of the sea.
- BAGGYWRINKLE—the service on standing or running rigging to prevent chafing where one rope crosses another. (See "bolster" and "scotchman".)
- BAR—a shoal or spit formed by the action of the tides at the mouth of a river or harbour.
- Barrack stanchion*—a man who has served for a long period in a Naval barracks or shore establishment.
- Bare navy*—members of a mess are said to live on "bare navy" when they feed solely on Service rations.
- BARE POLES—a sailing vessel is said to be under bare poles when she is underway and has no sails set.
- BARGE—a cargo-carrying coastal sailing vessel. In the Royal Navy, the boat of a Flag Officer.
- BARRATRY—fraudulent claim for compensation (as when a ship is deliberately wrecked or scuttled (which see) to obtain her insurance money).

TO BATTEN DOWN—to close all openings in the weather decks or superstructure of a ship, or to close all openings in one of her compartments.

Beach—*on the beach* means retired from sea service. (See *swallow the anchor*.)

BEAM ENDS—a ship is said to be on her beam ends when she is lying over on her side with her beams and decks perpendicular. The expression is used colloquially to describe a precarious position.

Bear—a large holystone which is dragged to and fro along the deck by lanyards (see "holystones").

BEAR A HAND—an order to hasten, or to do something smartly, quickly.

TO BELAY—colloquially, to countermand an order (see *wash out*).

BELOW THERE !—a hail from a man aloft to anyone below him.

BERTH—the allotted place or position for a ship or a man. "To give a wide berth" is to keep well clear of anything. "To shift berth" is to change position.

BETWEEN-DECKS—a general term applied to the space or the decks between the upper deck and the lowest deck of a ship.

Bibles—medium sized holystones (which see).

Bilge—rubbish, nonsense.

BILL—a certificate, or a written agreement, such as a "Bill of Health", "Bill of Lading", and a "Bill of Exchange".

BITTER END—the inboard length of a ship's cable. (The cables of ships at anchor used to be belayed to specially fitted centre-line bollards called "bitts").

TO BLEED—to drain a buoy of water. *To bleed the monkey*—to extract the contents of a rum barricoe by boring a small hole in it.

BLOCK-AND-BLOCK, TWO-BLOCKS—these terms describe the state of a tackle when its standing and moving blocks are hauled close together. Colloquially they are used to describe the position of two objects which are close together. (See "chock-a-block").

TO BLOW THE GAFF—to divulge information you have learnt confidentially, to give away a secret. Its origin probably lies in a ship revealing her identity by hoisting her colours at the peak of her gaff.

BLUE-JACKET—a seaman of the Royal Navy. (From the short blue jacket he used to wear.)

BLUFF—a headland with a broad, perpendicular face. Hence, "bluff-bowed"—a ship with broad perpendicular bows.

BOARD (1)—the old name for the side of a ship, from which the following terms also are derived: "to go aboard"—to enter a ship; "to board"—to enter a ship by force or authority; "boarders or boarding party"—a body of men detailed to board a ship; "inboard"—between the sides of the ship; "outboard"—outside the ship; "on board"—anywhere in the ship; "to go by the board"—to fall over the ship's side; "board and board"—alongside, side by side and touching; "close aboard"—close to the ship's side; "starboard"—the side on which the steering oar or "steer-board" was formerly shipped (the right-hand side when in the ship or boat and facing

forward) ; "larboard"—the opposite side to starboard, over or through which the cargo was embarked or disembarked, and originally spelt "lade-board".

(2)—the distance made good by a sailing vessel between two successive tacks when beating to windward.

BOBSTAY—properly the stay leading down from the nose of a sailing vessel's bow-sprit to her stem near the waterline, but also applied to any stay used in a similar fashion (see "martingale").

BOLSTER—a pad or cushion of canvas or leather used to prevent chafe between ropes, or a piece of wood or metal used to give a fair lead to, or prevent a bad nip in, a rope. (See "scotchman" and "baggywrinkle").

To Bone—to scrounge, pilfer or steal. (Derived from a boatswain of that name who served in the flagship of Admiral Cornwallis and was notorious for acquiring ship's stores from other ships to make good deficits or provide a surplus in his own ship. When the boatswain was leaving the ship the Admiral is said to have remarked, "I trust, Mr. Bone, you will leave me my bower anchors").

BONNET—any small cover or hood, of canvas or metal, used to cover or protect a small fitting or opening.

BOOMKIN OR BUMPKIN—a small boom.

BOOT-TOPPING—properly the operation of scraping marine growths from the waterline, but also as the name for the painted band, four or more feet wide in a large ship, extending from stem to stern of the ship along her waterline ; the paint used is usually of a different colour or shade to the sides and bottom, and is of a special composition designed to prevent the growth of marine organisms which otherwise always form between wind and water.

Bottle—a reproof or admonishment (contracted from *a dose from the foretopman's bottle*, which was a cure for all evils).

BOTTOMRY—a system of pledging the hull of a ship as security for a loan.

BOUND (1)—restrained, tied, fettered ; as in "weather-bound", "wind-bound", "tide-bound" ; and "iron-bound coast", which is used to describe a rocky and dangerous coast with no shelter.

(2)—ready to go to a destination, or on the way to a destination ; as in "outward bound", "homeward bound".

To BOWSE—to haul on a rope ; "bowse down"—to tauten a rope or a lashing.

To BREAK BULK—to start unloading a full hold.

To Break surface—to wake up or come to life (has its origin in a submarine "breaking surface" after being submerged).

BREECHING—a rope which limited the recoil of the old-fashioned gun mounted on wheels ; hence any rope used in a similar fashion (see "crupper").

Brick—a gun projectile or shell.

BRIGHT-WORK—polished metal fittings.

To BROACH—to break into or open for the first time, a cask, package or similar object.

TO BROACH-TO—when applied to a vessel running before the sea, is to slew round inadvertently broadside on in the trough of a wave.

BROKEN WATER—surf caused by breaking waves.

To Bull a cask—to put a small quantity of water into an empty rum cask and leave it there until it becomes grog.

BULL'S-EYE (1)—a light built into a bulkhead between adjacent compartments so that it illuminates both.

(2)—a thimble made of hard wood and usually inserted in the end of a lizard, or used as a small leading block (see “dead-eye”).

Bullocks—the name formerly given to men of the Royal Marine Artillery because of their magnificent physique. (see *jollies*, *turkeys*, *pongos*, and *grabbies*).

BULL-ROPE—a rope led from the ring of a buoy to the nose of the bowsprit of a sailing vessel, or to the stem head of a clipper-bowed ship, to prevent the buoy from bumping the bows at slack water.

BUM-BOAT—a shore boat carrying fresh provisions or small merchandise for sale to ships in a harbour. “Bum-boatman”—the owner of such a boat, or of her stock in trade.

Bundleman—a married man. (Originates from the days when men could buy ship's provisions for their families, and the married man could then be distinguished when going ashore by the bundle of provisions he carried.)

BUNT—the belly of a sail, and the middle of a yard.

Bunts—a signalman. (Derived from bunting.)

BURDEN—the carrying capacity of a merchant vessel. It is expressed either in tons weight or in tons of cubic capacity.

BUTT-END—the largest end of a spar, or any similarly shaped object.

Buzz—rumour (see *galley packet*).

BY-AND-LARGE—under all conditions, generally speaking. (Derived from the sailing terms “by the wind” meaning close hauled, and “sailing large” meaning running or sailing free.) (See “large”.)

BY THE HEAD—a vessel trimmed more deeply forward than aft.

BY THE STERN—a vessel trimmed more deeply aft than forward.

CAMEL—a tank secured to the hull of a ship to provide her with extra buoyancy, used mainly in salvage work.

To Cag—to discuss, to argue.

CANT—to incline from the perpendicular.

CAPFUL OF WIND—a puff of wind on a calm day, but of sufficient strength to fill a vessel's sails. (See “catpaw”.)

To CAPSIZE—to overturn, to turn bottom upwards.

To CARRY AWAY—to break away, or to part.

To CAST—to pay a vessel's head off on a course, or on a new tack.

CAT, OR CAT-O'-NINE-TAILS—a former instrument of punishment in the Navy. It was originally made of nine lengths of cord, with three knots at the end of each, spliced to a short length of thick rope to form a handle. *No room*

to swing a cat means that there is insufficient space in which to wield a cat-o'-nine-tails.

CATSPAW—a light puff of wind on a calm day, just strong enough to ruffle the surface of the water ; usually the fore-runner of a sailing breeze.

To CAULK—to drive oakum or other similar caulking material into the seams of planking to make them water-tight ; after caulking the seams are " paid " by pouring molten pitch into them to preserve the caulking. Also, colloquially, to lie down and snatch some sleep, which has its origin in the fact that a man who had just *taken a caulk* on a hot deck could be identified by the marks of pitch on his clothing.

Charlie Noble—the funnel of a galley or a stove when sheathed in brass and polished.

CHATHAM CHEST—a fund, established by Queen Elizabeth after the Armada for the care of wounded and infirm seamen. It was supported by contributions from the men, which were kept in a special chest at Chatham. This chest is now (1949) to be seen at the National Maritime Museum, Greenwich.

Chats—Chatham.

Chippy chap—a shipwright.

CHOCK-A-BLOCK—full up (from " choking " the luff of a block (which see under " choked ")). *Chock-a-block* and *chocker*—slang terms for bored or " fed up ".

CHOKED—a block is said to be choked if its fall jams in the swallow. " To choke the luff " is to choke the block of a tackle by leading the bight of the hauling part across the swallow of the block and jamming it between the swallow and the running parts, thus preventing the tackle from overhauling.

CHOPS OF THE CHANNEL—the entrance to the English Channel (derived from " chap " or " chop " meaning jaws).

CHOPPY SEA—a short, steep and usually confused sea.

Chummy ships—ships whose respective officers and men are on particularly friendly terms.

CLAP ON—an order to man a fall or a halyard. To attach one tackle to another or to a rope.

To CLEAN—to dress in the " rig " (suit of clothing) ordered, or to change from night clothing or working rig into a clean rig.

To CLENCH, OR CLINCH

(1)—to join a rope to a fitting or to another rope by a half hitch with the end seized to its own part. This method was formerly used to join one end of a ship's hempen cable to her anchor, and the other end to the housing of her mainmast. A " clench ", nowadays, is a strong fitting securely attached to a deck or the hull structure, to which the end of a cable or hawser is shackled. A cable or rope is said to be " out to a clench " when it has all run out, or been paid out, but its end is secured inboard.

(2)—to fasten two pieces of wood together by driving nails through both and turning their ends over (as in " clinker " or " clencher " built boats), or to hammer over the end of a bolt to prevent it from withdrawing from its hole (as in a " clenched shackle ").

CLEAR—good visibility as in “clear weather”, or as in a “clear sky” meaning that it is cloudless; free from shipping, or obstructions—as in “clear horizon” and “clear channel”.

TO CLEAR—to free, the reverse of to foul (which see); to make free (a rope clear for running, to clear a block); to put in order, to tidy (to clear up decks); to pass an obstruction safely (to clear a point of land); to empty (to clear a hold or a lighter); to pay port or customs dues, and complete port formalities (to clear quarantine, or to clear Customs).

COASTER—a vessel which plies between the harbours of a particular coast or adjacent coasts, usually in pilotage waters and seldom out of sight of land.

A’COCK-BILL—an anchor is said to be a’cock-bill when it is hung up-and-down, ready for letting go. Yards are said to be a’cock-bill when they are topped at an angle with the horizontal (see “scandalise”).

COME UP !—an order to slack off rope.

TO COME UP WITH A VESSEL—to overtake her.

COMPANION LADDER—a ladder or staircase leading from the poop or upper deck of a merchant ship to the saloon or main cabin.

TO COMPLAIN—a block is said to complain when its sheave squeaks.

Copper-bottomed—well found, reputable. (The bottoms of wooden ships were sheathed with copper to protect them from marine parasites, but being very expensive this was only done to ships whose owners were of substance and repute).

CRAB—a small hand capstan.

TO CRACK ON—to set more sail, to increase speed.

CRANK—a ship is said to be crank when she heels readily to one side or the other and returns sluggishly to the upright. (See “tender” and “stiff”).

CREEPER—a grapnel (which see) used for sweeping or dragging for objects lost overboard. (See “to drag” and “to sweep”).

CROWFOOT OR CROW’S FOOT—three or more lines or small ropes radiating from the end of a whip or pendant, so that its support or pull is spread and divided between them. The lines are kept apart by an “euphroe” (which see).

CROW’S NEST—a small shelter for the masthead look-out, sometimes formed by a cask secured to the mast.

CRUPPER—any rope used to prevent something from sliding backwards or recoiling (see “breaching”).

Crusher—a member of the ship’s police.

CUDDY—the Master’s cabin in sailing vessels, and the slang term for the Admiral’s or Captain’s cabin.

To Cut and run—to escape or quit. (Derived from the days when a ship cut her hemp cable and left her anchor on the bottom to enable her to put to sea quickly in emergency; also, in similar circumstances, when she set her sails by cutting their gaskets, so unfurling them at the run).

CUT-WATER—the stem of a ship. (In sailing vessels with bluff bows it was a false stem).

CUT OF HER (OR HIS) JIB—the general appearance of a ship or person.

Davy Jones' locker—bottom of the sea. The origin of the term is obscure, but it may have originated in a pirate of that name who made his prisoners walk the plank.

D.D.—the letters inserted in the Ship's Ledger against the name of a deceased officer or man to denote the closing of his account and signifying that he was "discharged dead".

DEAD-EYE—a block of hardwood with one or more holes drilled in it to take a rope or ropes or the fall or a simple purchase; the earliest form of block.

Dead marine—an empty bottle, which "has done its duty and is ready to do it again".

Dead men—stray ropes ends hanging from aloft (see *Irish pendant* and *hanging Judas*).

DEEP—(1) a depression in the sea bed.

(2) the fathoms on a lead line which are not marked, *i.e.* "Deep, six".

DEMURRAGE—compensation paid to the owner of a vessel which has been delayed in port beyond the time agreed upon.

DERELICT—a ship afloat but abandoned by her crew.

DEVIL—in wooden ships a large seam near the gunwale. "*Between the devil and the deep sea*"—between the gunwale and the waterline; any precarious position.

Dhobeying—washing clothes (derived from the Indian word "dhobey"—a washerman).

DHOW—an Arabian sailing vessel.

TO DIP—to lower partially and temporarily. As slang this is used for disrating, forfeiting a good conduct badge, or failing an examination.

Ditch—the sea. "*To ditch*" is to throw overboard.

DITTY-BOX—a small wooden box which was issued to seamen as a receptacle for their small personal effects, but in 1938 was replaced by an attaché case.

DIVISION—two or more ships or vessels of a squadron or a flotilla under one command. (See "squadron" and "flotilla").

To Dodge Pompey—to evade doing a job of work.

DODGER—a canvas screen laced to guardrails to provide shelter from wind or spray. In the Royal Navy a slang term for a sweeper (which see).

TO DOG—to twist a rope round a spar or another rope to obtain a grip of it.

DOG-VANE—a small wind-vane of bunting secured to the weather shrouds of a sailing vessel. (See "wind-vane").

Doggie—a Midshipman detailed to attend on a senior officer.

DONKEY—a prefix given to any small mechanical contrivance for saving labour, such as the "donkey engine" used for working winches or small capstans, and the "sailmaker's donkey" or sewing machine.

DOREY—a flat-bottomed boat carried by fishing vessels.

TO DOWSE—to lower or slacken suddenly, to extinguish. "*Dowse the glim*"—to put out the light. (See *glim*).

TO DRAG—to haul a grapnel (which see) or some similar instrument along the sea bed to recover something lost. (See "to sweep").

TO DRAW—a sail is said to draw when it is filled by the wind. A ship is said to draw so many feet (in draught). A ship is said to draw ahead of you if her position relative to yours advances, and to draw astern if it drops back.

TO DREDGE—to deepen a channel by excavating it.

DRIFT-ICE—ice broken away from the main pack.

To Drip—to grumble or grouse.

TO DROWN—to drench or immerse. To drown a boat is to fill her with water by removing her plug, and is done to swell her planks and make her seams tight.

DUNNAGE—pieces of wood, matting, old rope, old canvas and other similar materials when used for raising cargo off the bottom of a hold, or packing it to keep it from shifting, or covering it to keep it dry.

EASY !—go or haul carefully, slowly, or less vigorously.

EDDY—a swirl in the water made by a fast moving current passing over a rock or a hollow in the bottom ; the swirl made by a current on the lee side of a rock or the buttress of a bridge, and the backwash of a current at the sides of a channel. Also a circular movement of the air.

END FOR END—to turn anything end for end is to reverse its position.

EUPHROE OR UVROE—a circular or oblong piece of wood, bored with holes and used to separate the parts of a crow's foot (which see).

TO FAG—to separate or tease out the strands of a rope (" fag-end " is the very end of anything).

FAIR—favourable, unobstructed, the reverse of " foul " (which see) ; as in " fair wind ", " fair lead " and " fairway ".

Fairweather friend—one who is a friend only for so long as it suits his own ends.

FAKE—a coil in a coiled rope.

Fanny—a cylindrical mess tin holding about a gallon. (The introduction of tinned meat into the Navy was not popular, and coincided approximately with the murder and dismemberment, in 1867, of a child called Fanny Adams. The tins in which the meat was packed were then used as mess utensils throughout the Service).

FIDDLE—a bar of metal or wood holding a number of sheaves in line, and used chiefly for signal halyards or the halyards of wireless aerials. Also, battens fitted over a mess table to keep the mess traps in place in rough weather.

TO FIT OUT—to rig and provide a ship with her complete equipment of gear, stores and provisions.

Flannel—a term describing a long-winded or meaningless speech ; also applied to nonsense or rubbish.

FLAT—a flat surface shoal or bank usually close inshore, which may or may not uncover at low water.

FLEET (1)—" The fleet " is a general name given to the Royal Navy as a whole ; a fleet is a number of ships under one overall command, and it can be subdivided into squadrons, flotillas and divisions (which see).

(2)—shallow tidal waters, e.g. Benfleet, Purfleet.

(3)—the span or scope of a rope or tackle ; the distance to which an object can be moved in one haul by a rope or tackle. " To fleet " anything is to haul it along in a series of fleets, and to fleet a tackle is to overhaul a tackle which is block and block to its full scope. " Fleet along ", " Fleet aft ", " Fleet forward ", are orders to a body of men to move carefully in the required direction.

(4)—the area covered by a stage when painting a ship's side.

FLOTILLA—a number of small ships or boats under one command.

FLOTSAM—floating cargo, stores, or equipment, freed from a wreck or cast overboard to lighten a ship. It is the property of the owners, and if not claimed it becomes the property of the Crown (see " jetsam " and " ligan ").

FLYING DUTCHMAN—the ghost of a sailing vessel which is said to haunt the waters off the Cape of Good Hope. The sighting of it is supposed to portend disaster.

FORE-AND-AFT RIG

(1)—a ship rigged with fore-and-aft sails only, as in a schooner.

(2)—a slang term for the dress of Royal Naval Chief and Petty Officers, and of men not dressed as seamen (see " square rig ").

FORE-FOOT—the lower end of the stem where it meets the keel.

FORE-PEAK—the compartment or space between decks in the bows of a ship.

FORESHORE—the beach below highwater mark.

FOUL—entangled, obstructed, or dirty.

Foul Anchor—the badge of the Royal Navy, consisting of an Admiralty pattern anchor with a rope fouling its stock, shank, and arms ; it originated in the badge of Lord Howard of Effingham, who held office as Lord High Admiral in the reign of Queen Elizabeth.

TO FOUNDER—to sink.

TO FRAP—to bind with lashing, to pass a rope round a sail or over an awning to keep it from breaking loose.

FREE—unobstructed, unencumbered, clear for running.

TO FRESHEN, OR FRESHEN THE NIP—to shift the position at which a rope is being chafed, by a fairlead for example, by paying it out or hauling it in a foot or so.

FULL DUE—to do anything " for a full due " means to do it permanently, e.g. to secure a rope or a fitting " for a full due ".

TO FURL—to fold up or roll up and stop a sail or an awning.

Gadget or Gilguy—a small mechanical fitting or contrivance, a dodge or device.

GALLEY—a single-banked, six-oared, pulling boat, properly called a " gig ", which until recently (1949) was provided for the use of the captain of a ship.

Galley-packet—a rumour, usually unfounded. (So-called because such rumours originated in the ship's galley or cook-house).

GANGWAY—any recognised entrance to, or passage way or traffic route within a ship. Also used as an order to make way for an officer.

GARLAND—a strop or rope sling round a mast or spar with which to lift or hoist it.

Gash—remnants of a meal ; leavings and pickings.

GASKET—a stop used for tying up a furled sail or awning.

GHOSTING—a sailing vessel or boat is said to be ghosting, or ghosting along, when she is making good way in a very light breeze.

GIG—(see “galley”).

Gilguy—(see *gadget*).

GINGERBREAD-WORK—the ornate gilt carving with which the sterns of former men-of-war were decorated. (The term is derived from the gingerbread sweetmeats formerly sold at fairs ; they were made of treacle or honey and gilded over).

GIRT OR GIRDED—bound. A vessel is said to be girt when she is moored so tautly that she is prevented from swinging to wind or tide by fouling her cables as she swings round. Also said of a tug when she is inadvertently hauled broadside on her tow-rope, in which position she is powerless and must slip the tow or be capsized. To “under-gird” is to bind the hull of a vessel with ropes or chains to strengthen it (see “swift”).

Glim—a light (see “dowse”).

Gobbie—a coastguard. Until 1923 H.M. Coastguard Service was administered by the Admiralty and manned by pensioners of the Royal Navy, but in 1923 its administration was transferred to the Board of Trade, and now (1949) it is administered by the Ministry of Transport. The term is also applied to men of the Royal Fleet Reserve.

Gobbie ship—a harbour service or Reserve Fleet ship, or a ship manned by Reservists.

Goffer or *Gopher*—a non-alcoholic fruit drink or mineral water.

Grabbies—soldiers (see *pongos*).

GRAIN—the line of water ahead of a vessel along which she will pass ; the opposite to “wake” (which see).

GRAPNEL—a small boat's anchor with three or four arms ; used also for dragging, and for grappling a floating object. “Grapnel-rope” is an old term for a boat's cable. (See “to drag”, “to sweep” and “creeper”).

GREEN SEA—an unbroken wave. A vessel is said to be “shipping it green” when unbroken water is driven aboard.

GROG—rum diluted with water ; in the Royal Navy the regulation mixture is two parts of water to one of rum. A “*Nor-wester*” is a mixture of one part water to one of rum ; the more northerly the direction the stronger the grog. (Grog was introduced to the Fleet in 1740 by Admiral Vernon, who was known as “Old Grog” because he habitually wore clothing made of material called program) (see “tot”).

Grog-blossom—a red nose or pimple.

GROUND SWELL—a heavy swell caused by a distant storm or by one that has passed ; it may also be caused by a submarine earthquake.

Guzz—Devonport.

HALF-TIDE ROCK—a rock which uncovers at half-ebb.

Hanging Judas—a fall, whip, or halyard, which is not properly secured aloft, or not properly belayed, or hanging loose from aloft. (see *deadmen* and *Irish pendants*).

Hard tack—ship's biscuits, which used to be very hard and tough (see *soft tack*).

Harry Freeman—free of charge, a gift, or something obtained for nothing. (The origin of this term is obscure).

HEADS—a ship's latrines. (The "heads" of a sailing man-of-war were platforms on each side of the stem which were used as latrines by the men).

HEAVER—a lever, handspike.

TO HOG OUT—to scrub out thoroughly. (A hog was a stiff brush used for scrubbing the ship's bottom).

HOLIDAY—a gap left in a row or line, of washed clothes for example; an unpainted patch in paintwork.

HOLYSTONES—blocks of sandstone used for scrubbing decks, so-called because their use entails kneeling down. (Medium sized holystones are called *bibles*, and small ones *prayer books*). (see *bear*).

Hook-rope party—a party of men detailed to give the decks a final clear-up just before an inspection.

HORSE LATITUDES—a belt of light and variable winds between the Westerlies and the Trade Winds in the northern and southern hemispheres in which sailing vessels were often becalmed for some time. (The name had its origin in the middle of the nineteenth century, when numerous horses were transported from Europe to America and the West Indies, and the belt in the North Atlantic was often studded with dead horses).

HULK—a vessel condemned as unfit for sea service, and used in harbour for some purpose such as a store ship or an accommodation ship (see "sheer hulk").

TO HULL A SHIP—to penetrate the hull of a ship with shot or shell.

Irish pendants—rope yarns, or stray rope's ends hanging in the rigging, or flags with frayed flies (see *dead men* and *hanging Judas*).

In everybody's mess, but nobody's watch—a phrase applied to a plausible, work-shy man.

JETSAM—sunken cargo which has been cast overboard to lighten a ship. If recovered it is the property of the owners, but if not claimed it is the property of the Crown (see "flotsam" and "ligan").

TO JETTISON—to cast overboard.

Jew—a tailor.

Jollies—Royal Marines (see *bullocks* and *turkeys*).

Jonah—a bringer of bad luck.

Joss—luck. (Chinese).

JUNK—old rope set aside for picking (see "rounding" and "rumbo").

JURY—a prefix meaning temporary, as in “jury-mast” for example, which is a mast specially made and rigged temporarily in place of a damaged one.

KEG—a small cask.

Ki—cocoa (the origin of this term is obscure).

KID—a small tub (see “spitkids”).

KILLICK—a small anchor. A slang term used for a Leading Seaman, because the distinguishing badge he wears is an anchor.

TO LABOUR—a ship is said to labour when she pitches and rolls heavily in rough weather.

LAGOON—a stretch of water enclosed, or almost enclosed, by a reef or an “atoll” (which *see*).

LANDFALL—first sight of land after a passage in the open sea.

LAND-LOCKED—surrounded by land.

LARGE—a ship is sailing large when she is sailing free with the wind abaft her beam; “an offender at large” is one who is not under constraint (see “by and large”).

TO LAY UP—to take a ship out of service. To twist the strands of a rope together.

LEAGUE—an obsolete sea measurement of distance equivalent to three nautical miles.

LEE-BOARD—a board lowered down into the water on the lee side of a sailing vessel to prevent her making lee-way when close hauled or reaching.

LEE-SHORE—a shore towards which the wind is blowing.

LEE-TIDE—a tidal stream running in the same direction as the wind (see “weather-tide”).

TO LET FLY—to let go instantly; usually applied to the sheets of a sailing vessel.

TO LET RUN—to let go a rope, chain, or other flexible object so that it runs out of its own accord.

LEVANTER—a strong easterly wind in the Mediterranean sea.

LIBERTY—leave of less than 24 hours.

TO LIE TO—to lie as nearly stationary as possible in a gale with the wind and sea ahead or on the bow.

LIFE-LINES—ropes rigged along the decks or gangways to afford a handhold in rough weather.

LIGAN—sunken cargo or gear which has been cast overboard and buoyed. It is the property of the owners, but if unclaimed becomes the property of the Crown (see “flotsam” and “jetsam”).

Lights—an extension of the regulation time for “lights out”, which may be granted on certain occasions.

To Lurk—to impose upon someone else's kindness, *e.g.* to persuade someone to take your trick or watch.

To Lush up—to stand treat ; (*lush* is sometimes used to mean abundant liquor, or, as an adjective, drunk).

MAKING—tides are said to be " making " during the period between neaps and springs when their height progressively increases (see " take-off ").

MANIFEST—an official inventory of all cargo carried by a merchant vessel.

MARTINGALE—a stay leading from the nose of the jib-boom of a sailing vessel to her stem ; in some ships it is passed through the head of a dolphin striker to give it a better downward pull on the jib-boom. Any stay which prevents a boom, spar, or strut from topping up is also called a martingale (see " bobstay ").

MASTER—the captain of a merchant vessel.

MASTER-OF-THE-FLEET—The navigating officer appointed to the staff of a Commander-in-Chief of a fleet and charged with the navigation of the fleet as such.

Maties—dockyard workmen.

MESS TRAPS—food utensils for a naval officers' mess.

MESS UTENSILS—food utensils for a naval ratings' mess.

Money for old rope—something for nothing, simple.

MONKEY—a prefix meaning small, *e.g.* " monkey's island ", " monkey jacket ", " monkey boom ", " monkey block ".

Mother Cary's chickens—small sea birds otherwise known as stormy petrels. (The origin of the term is legendary ; it was well known among English seamen in the days of Captain Cook.)

TO MUFFLE—to muffle the oars is to parcel their looms with canvas where they pass through the rowlocks or crutches to prevent them from creaking.

MULCT—a fine imposed as a punishment ; " to mulct " is to fine.

Mungy—food (derived from the French " manger "—to eat).

Mundungus—rubbish (derived from the Spanish " mondongo " meaning tripe).

MUZZLER—a gale blowing from right ahead.

NEAPED OR BENEAPED—a vessel which cannot leave harbour except at spring tides is said to be neaped ; the term also describes a vessel grounded at the height of a spring tide which cannot be refloated until the next spring tides.

Neaters—neat rum.

Nick names in general use afloat—" *Granny* " Anderson and Henderson ; " *Daisy* " Bell ; " *Wiggy* " Bennet ; " *Nigger* " Black ; " *Ginger* " Casey ; " *Nobby* " Clark ; " *Jumper* " Collins or Short ; " *Bandy* " Evans ; " *Harry* " Freeman ; " *Jimmy* " Green ; " *Tosh* " Gilbert ; " *Chats* " Harris ; " *Cosher* " Hinds ; " *Jerry* " King ; " *Bogie* " Knight ; " *Dodger* " Long ; " *Pincher* " Martin ; " *Dusty* " Miller ; " *Spud* " Murphy ; " *Nosey* " Parker ; " *Spike* " Sullivan ; " *Buck* " Taylor ; " *Hookey* " Walker ; " *Sharkey* " Ward ; " *Knocker* " White ; " *Slinger* " Woods ; " *Shiner* " Wright.

NIPPER—a stop or strop used temporarily to seize two ropes together. A slang term for boys, which was originally given to the boys who provided the nippers for nipping the hempen cable of a sailing ship to the messenger when weighing anchor.

NORTHERN LIGHTS—the “Aurora Borealis” seen occasionally in the northern sky when in high latitudes at night. The similar “Aurora Australis” or “Southern lights” are seen in high southern latitudes.

Nor-easter—the same as “not entitled” (which see). (A north-easterly wind is an unpopular one, particularly in winter).

Nor-wester—(see “grog”).

NOT ENTITLED—a report at a naval pay table signifying that a man is not due for any pay.

OFFING—that vaguely defined part of the sea which lies between the entrance to a harbour, or the shoal water of a coast, and the horizon.

Opposite number, or Oppo.—a man having the same station or duties as your own; e.g. the opposite number of a man in the port watch is the man in the starboard watch who carries out the same duties.

TO OVERHAUL

(1)—to overtake.

(2)—to examine carefully and repair where necessary.

(3)—to haul the blocks of a tackle apart to the full scope of the fall.

PACKET—a small mail and passenger vessel.

TO PASS THE WORD—to relay an order or a summons.

TO PAY—to give a coating to a surface.

TO PAY A SEAM—to pour molten pitch into a seam.

TO PAY AWAY—to slacken a rope.

TO PAY OFF—to fall away from the wind. Also to place a ship out of commission (in former times the ship's company were then paid their wages and discharged).

TO PAY OUT—to ease out by hand.

PEAK—Fore peak, the space immediately abaft the stem of a ship; after peak, the space immediately before her stern post. These spaces are often used in merchant ships for storage of fresh water in what are known as peak tanks.

Perks—perquisites; i.e. allowance in cash or kind appertaining to a particular office or employment.

Pier-head jump—joining a ship late, just as she is about to sail.

PIPE DOWN—the last routine pipe of the day after which silence is maintained throughout the mess decks until the hands are called. May also be given verbally as an order to stop talking, arguing or skylarking.

Plushers—the residue of the grog ration of a mess if the tots served out were of short measure, or if the ration served to the mess was over measured.

Pompey—Portsmouth.

Pongo—soldier (see *grabbies*).

PORT—a square or rectangular hole cut in a ship's side as an entrance for embarking passengers or cargo, or for light and ventilation.

Prayer books—small holystones (which see).

PREVENTER—any rope used as an additional stay for standing or running rigging, or used to limit the movement of some fitting or spar.

Private ship—any large ship other than a flagship, and commanded by an officer of Captain's rank.

PROUD—projecting from an otherwise flat surface, such as the head of a rivet which is not counter-sunk. The term is also applied to a wooden shore which is cut slightly longer than the space into which it is to fit, so that it has to be driven home when set up and so be jammed in place.

PUDDING—a rope fender, cylindrical in shape and sometimes with the ends tapered; generally used on the bows of tugs and harbour launches, also on the griping spar of a sea-boat.

PURSER—the officer in a merchant ship responsible to the Master for the catering and accommodation of passengers. Formerly the officer in a ship of the Royal Navy charged with her provisions and clothing stores was called the Purser.

Pusser—(colloquial derivation of Purser) the Supply Officer of a warship. "*Pusser's dip*"—a candle; "*pusser's dirk*"—a clasp knife; "*pusser's crabs*"—shoes; "*pusser's medal*"—a food stain on clothing.

Queen's hard bargain—a lazy, incompetent man.

Rabbit—any article made or converted from ship's stores for private use.

RACE—(see "tide-race").

Raggie—friend or chum. (Formerly, seamen provided their own cleaning gear, and if two men shared their cleaning rags it was a sign of trust and friendship). "*To part brass rags*" is to dissolve a friendship.

TO RAKE—to lean or incline from the perpendicular. To fire into a ship along her length. The term "*rakish*" is applied to a ship with an appearance of force and speed.

TO RANGE—to lay out (usually applied to rope or cable).

Rattle—to be "*in the rattle*" is to be on the list of defaulters, or in the "report".

TO REFIT—to repair, put in order, recondition.

RELIEF—the man who relieves another of his watch, trick or other specific duty.

RELIEVING TACKLES—tackles or ropes secured to the tiller of a vessel to assist her steering in a heavy sea.

RENDEZVOUS—place designated for the meeting or assembly of ships.

RIGOL—a curved metal fitting above a side scuttle to prevent water running down the ship's side from entering the scuttle.

ROAD, ROADSTEAD—an exposed or offshore anchorage.

Rockie—an officer or man of the Royal Naval Reserve.

ROGUE'S YARN—a coloured thread laid up in a strand of a fibre rope. It was formerly used to distinguish Service cordage from commercial cordage to prevent misappropriation of the former, but it is now used to distinguish one type of cordage, whether Service or commercial, from another. Service

cordage, however, can still be distinguished from commercial cordage because the distinguishing colours of the former are different from those of the latter.

Rogue's salute—the gun fired on the morning of the day appointed for a Court Martial.

ROUNDING—condemned rope under 4 inches in size. Also any service on a rope or a spar (see “junk” and “rumbo”).

To ROUND UP—to haul together the two blocks of a tackle to a convenient scope for stowage.

RUMBO—condemned cordage. (See “junk” and “rounding”).

RUMBO-LINE—rope made from old rope, such as stage lashing.

RUN (1)—the distance sailed (steamed) by a ship.

(2)—the note made in the ship's ledger against the name of a deserter. “To run” is to desert.

To RUN DOWN—to ram a vessel, either on purpose or by accident.

RUNNERS—smugglers.

To SCANDALISE—to settle the halyards of a gaff in order to spill the wind out of its sail (see “a'cockbill”).

SCANTLINGS—standard dimensions for the various parts of a ship's structure; they vary with the type or class of ship.

SCEND—the scend of a sea is the vertical movement of its waves (see “Surge”).

To SCEND—a ship is said to scend when she rises and falls bodily on the crests and in the troughs of heavy seas; it is different from pitching, in which the bows and stern of a vessel are alternately raised and lowered (see “surge”).

SCOTCHMAN—any piece of metal, wood, leather, canvas or other material used to prevent chafe or wear (see “baggywrinkle” and “bolster”).

Scran—food. A “*scran-bag*” was formerly used as a receptacle for the remains of a meal, but is now used as a stowage for personal gear, such as clothing which has been left lying about, until it is claimed by the owner; it is customary to pay a forfeit of a bar of soap for anything reclaimed.

SCUD—low, fast moving clouds. A sailing ship is sometimes said to be scudding before a gale when she is running before it.

Sculling—to leave something sculling is to leave it lying about or unattended.

To SCUPPER—to sink, to founder (from water flooding aboard through the scuppers). “*I'm scuppered*”—an expression of defeat or resignation.

To SCUTTLE—to cut a hole in a ship's bottom, or to open her seacocks, for the purpose of sinking her.

Sea-daddy—an experienced seaman detailed to instruct youngsters; sometimes applied to the officer in charge of the Midshipmen.

Sea-lawyer—an argumentative man; one more given to questioning orders than readily obeying them, and to talking rather than working.

Sea-legs—a man is said to have “got his sea legs” when he can move about his ship without losing his balance when she rolls or pitches heavily.

SEWED (pronounced "sued")—a ship is said to be sewed when she has been grounded on a falling tide, either intentionally or accidentally, and can only be refloated by the rising tide ; the difference between the actual level of the water and the level to which it must rise to refloat her is the distance by which she is sewed. She can also be described as being sewed to a certain point, *e.g.* if the water was level with the bilge keel she would be "sewed to the bilge keel". The term is also used to describe the condition of a ship in this respect during the operations of docking and undocking in a dry dock. The term derives from the old English verb "to sew" meaning to drain.

TO SHAKE—to cast off fastenings ; to take to pieces, a cask or a packing case for example.

SHEER HULK—a hulk (which see) on which sheers have been erected.

SHEER PLAN—a drawing showing the longitudinal cross section of a vessel through her keel.

SHIP'S COMPANY—all the personnel of a warship other than her officers. The synonymous term in the Merchant Navy is "crew".

TO SHIVER—to break in numerous pieces, to shatter.

SHIP-SHAPE—seamanlike in appearance.

To Shove in your oar—to break into a conversation ; to interrupt or interfere.

SICK BAY—the ship's hospital.

SIMOOM—the Arabic name for Sirocco (which see).

SHOT MAT—a heavy, rope mat used to protect anything, especially the deck, from heavy weights being dropped on it. (Originally to protect the deck from cannon shot being dropped on it).

SIROCCO—a sultry, oppressive, and often dust-laden southerly wind which blows in late summer into the Mediterranean from the deserts of North Africa. (See "Simoom").

SISTER SHIPS—ships built to the same design.

Skate—a man always in trouble or mischief.

SKIPPER—Master of a fishing vessel or of a small trading vessel. A rank in the Royal Naval Reserve.

TO SKULK—to avoid duty.

SLOPS—articles of uniform clothing made for the Crown and issued on repayment to officers and men of the Royal Navy.

Snob—a shoe maker.

SNOTTER—a strop supporting the heel of a swinging boom, derrick, or sprit (which see). A rope or chain stopper used to hold the lifts of derricks. A type of rope or chain sling.

Snowball hitch (slippery hitch) a hitch that will slip under strain.

TO SNUB—when applied to a rope or a cable, means to stop suddenly.

SNUG—properly secured ; "snugged down"—prepared to meet a gale.

Soft number—an easy job or duty ; a sinecure.

Soft tack—bread (see "hard tack").

TO SPEAK—to communicate at sea with another vessel or a shore signal station by visual signalling.

SPELL—a period of continuous work, such as a “spell at the pumps”; or a period of leisure such as “a spell on deck”. “Spell ho!” is sometimes used as the call for a relief.

SPINDRIFT—spray blown from the crests of waves.

Spithead pheasant—the bluejacket’s term for a kipper.

SPITKID—a small tub or other receptacle, placed on the decks during smoking hours, for cigarette ends, pipe dottles and waste paper.

SPLINTER MAT—a rope mat, with one side smooth and the other thrummed (or tufted), used for stopping small leaks in the hull of a vessel (see “thrums”).

SPONSON—a platform built out from the side of a ship.

TO SPRING—

(1) to split or crack. A “spring” is a crack in a spar, and a sprung spar is one which is weakened by splits or by cracks. When a vessel makes water through straining her hull she is said to “spring a leak”.

(2) A spring is a hawser laid out to slew a vessel, or to point her in some required direction. “To spring a boat ahead” is to haul her ahead on a guest-warp or a boat-rope.

SPRING-PIPE—A short pipe running through bulwarks and used as a fairlead for hawsers.

SPRIT—a boom used for supporting and extending the mainsail of a sailing vessel; it extends from the tack to the peak, and its heel is supported by a “snotter” (which see).

SPURN-WATER—a wooden or metal beading, or low coaming, round the edges of decks or waterways to prevent wash-deck water spilling over the ship’s side. The term is also applied to the breakwater on a ship’s forecastle.

SQUADRON—a number of battleships, aircraft carriers, or cruisers under one command (see “division” and “flotilla”).

SQUARE RIG—the rig of a ship whose sails are set on yards athwart her masts. A slang term for the uniform of a seaman or stoker of the Royal Navy below the rate of petty officer (see “fore-and-aft rig”).

To Square yards (with anyone)—is to agree with him, or to enter into agreement with him.

To Square one’s own yard arm—to put oneself in the right, usually with a superior, without regard for others; to observe the letter of the law (or of regulations or instructions) with the object of avoiding possible blame.

TO STAND—to sail in a certain widely defined direction, *e.g.* “to stand in to the shore”. “to stand southward”.

STANDING—a term denoting anything fixed or permanent, *e.g.* “standing rigging”, “standing guy”, “standing orders”, and “standing number” (*i.e.* a permanent job).

STATION (1)—a man’s place or post for a specific duty, *e.g.* “night action station”, “station for leaving harbour”; or the allotted position of a ship at sea with a fleet, squadron or flotilla. “To station” is to allot a place or duty to a man or a ship.

(2)—an area of land and sea placed under the naval jurisdiction of a Commander-in-Chief, *e.g.* China Station, Home Station.

TO START—to move from rest, to loosen, to break out, or to allow to move from rest as in starting a boat's falls.

TO STAVE—to break in a plank or a stave, *e.g.* of a cask ; " to stave in "—to hole anything or break into it ; " stove in "—holed, *e.g.* the bows or side of a vessel which has been in collision.

STEVEDORE—a man qualified to stow cargo in ships.

STIFF—very stable, the opposite of " crank ". Such a ship will return quickly to the upright when heeled over.

(See " crank " and " tender ").

Stone frigate—a naval shore establishment.

THE STRAITS—the straits of Gibraltar.

TO STRIKE—

(1) a ship is said to strike when she hits the bottom. A ship on an ocean passage when approaching land is said to " strike soundings " when she reaches water sufficiently shallow for taking soundings.

(2) To lower from aloft ; " to strike the colours " is to haul them down in token of surrender. " Strike down " is to lower anything into the hold of a ship or between decks.

TO STRIP TO A GANTLINE—to strip a ship of all her rigging, leaving one gantline rove to the masthead with which to begin refitting the rigging when required.

Strongers—a strong solution of soda and water used to dissolve dirt on decks.

SULLAGE—garbage, rubbish. " Sullage lighter "—the lighter which, in some ports, is sent to ships to collect their sullage and so prevent the harbour from being fouled by jettisoning it. (See *gash*).

SURGE—the lateral movement of a stationary vessel caused by a swell or the wash of a passing ship (see " scend ").

To Swallow the anchor—to retire from sea service.

SWASH-WAY—a channel across or between shoals or spits.

SWEAT—moisture on bulkheads, decks, deckheads and sides of a ship due to condensation.

TO SWEAT UP—to give an extra hard pull on a rope to take down every vestige of slack in it.

SWEEPER—In the Royal Navy, a man charged with the cleanliness of a compartment or a flat (see *dodger*).

SWEEPS—large oars used to propel lighters, barges and small sailing vessels.

TO SWEEP—to drag the bight of a wire or chain along the bottom to locate or recover a sunken object. (See " to drag ").

TO SWIFT—to tauten, to bind, to stay ; shrouds are swifted when the slack in them is taken down ; a shaky vessel is swifted (or " under girded ") when her hull is bound round with hawsers or chains (see " girt ") ; the outer ends of capstan bars are swifted to keep the bars shipped in the capstan-head.

TO SWIG OFF—to haul out on the bight of a taut rope at right angles to its lead in order to take up the last few inches of slack in its span. (Usually applied to halyards and lashings).

To Swing the lead—to avoid duty by feigning illness, to malingering. (See " to skulk ")

TAFFRAIL—the top rail round the stern of a ship from quarter to quarter.

To **TAIL ON**—to clap on to a rope (see “clap on”).

To **TAKE CHARGE**—an inanimate object, such as a rope or a cable, takes charge when it gets out of control and runs out by its own momentum.

To **TAKE OFF**—the tides are said to be taking off while they decrease progressively between springs and neaps (see “make”).

To **TAKE UP**—to tauten, to absorb, to swell; to “take up the slack” of a rope or nut, for example; when a dry boat is placed in the water her planking will gradually take up and become tight; when applied to “slops” (which see), it means to buy.

TAKEN ABACK—surprised; a sailing vessel is said to be taken aback when the wind strikes her sails on the wrong side.

TALLY—a label or the name of a person or an article. “To tally”—to keep a record, of stores or cargo being embarked or disembarked, for example.

Tanky—is the Navigating Officer’s assistant in the Royal Navy. (In former days the navigating officer, then known as the “Master”, was also responsible for the stowage of water in the ship’s tanks and for the stowage of the holds).

Tar, or Jack Tar—name formerly applied to a seaman of the Royal Navy (from his tarpaulin hat and tarry trousers).

TARPAULIN—a heavy canvas cover, tarred or painted; usually used to cover hatches to make them water-tight.

To **TELL-OFF**—to detail men for work.

Tell that to the Marines—a seaman’s repartee to an improbable story.

TENDER (1)—a small vessel employed to attend on a larger vessel, for duties such as ferrying, store-carrying or training. She is under the direct command of, and her accounts are kept by, her parent ship.

(2)—a term applied to a ship having poor stability; one which rolls easily and recovers slowly, the same as “crank” and the opposite of “stiff” (which see).

THRUMS—short rope yarns forming the tufted surface of a mat (see “splinter mat”).

Ticklers—Service tobacco issued in tins. The term originated in the tinned jam which was first supplied to the Navy in 1908 by a manufacturer of the name of Tickler, and was later applied to short service Ordinary Seamen.

Tiddie-oggie—the bluejacket’s term for a small flat meat pie of oval shape, called in the West Country a Cornish pasty.

Tiddley—neat, smart.

TIDE-RACE—a fast moving turbulent stretch of water, often with eddies and whirls in it, caused by a strong current meeting a tidal stream or a heavy sea or swell, or passing over a sharply uneven bottom. A race is nearly always found off the pass into the lagoon of an atoll (which see).

TIDE-RODE—a vessel at anchor in tidal waters is said to be tide-rode when she is lying swung to the tidal-stream rather than to the wind. (See “wind-rode”).

TIGHT—water-tight.

- TIMONOGUY**—a guy fitted to a projecting fitting to prevent a rope from fouling it.
- TOMBOLA**—a game similar to a lottery played on board H.M. ships, another name for which is " House ".
- TOP-HAMPER**—top-weight, *i.e.* any weight carried, either temporarily or permanently, above the upper deck ; superstructures, masts, funnels and deck cargo are examples.
- TOT**—the ration of rum or grog issued to ratings of the Royal Navy.
- TRIATIC STAY**—a stay led from the head of the mainmast to the head of the foremast. It was formerly used for staying the mainmast, but it now serves as a jackstay to support signal halyards or wireless aerials.
- TRICK**—a short spell of special duty involving continuous work or alertness. Tricks are carried out in turn by men of the watch on deck, and their length depends upon the nature of the duty ; look-outs do from half an hour to an hour, helmsmen one hour, and leadsmen as circumstances require.
- TRINITY HOUSE**—a corporation which is the general authority for lighthouses on the coasts of England, Wales, and the Channel Islands, and the pilotage authority for the London and Isle of Wight districts as well as 40 other ports in England and Wales. It was granted its first charter by Henry the Eighth, in 1518. Its members are elected from Master Mariners, the senior being known as " Elder Brethren " and the junior as " Younger Brethren ". As a private guild it administers certain charitable trusts for the relief of aged or distressed Master Mariners and their dependants.
- Turkeys**—the name formerly given to men of the Royal Marine Light Infantry because of the red tunics they wore (see *jollies* and *bullocks*.)
- TWO BLOCKS**—(see " block-and-block ").
- Uckers**—the sailor's name for the game of Ludo ; a game of skill and chance played with counters and dice.
- ULLAGE**—the quantity a cask, case, or tank lacks of being full.
- ULOING**—a Chinese method of sculling with a single oar shipped over the stern of a boat. The oar is pivoted about a round-headed pin on the transom, and its loom is secured to the bottom of the boat by a martingale of rope or chain.
- UNSTABLE**—a ship is said to be unstable when she is top heavy and so is unable to recover when heeled over by wind or sea. (See " crank ", " stiff ", and " tender ".)
- UVROE**—(see " euphroe ").
- Wet**—stupid. *Wet as a scrubber*—extremely stupid.
- WIND-VANE**—a thin strip of metal mounted on a vertical pivot on the head of a mast, or other suitable place aloft, so that it will indicate the direction of the wind in relation to the ship's course and speed.
- WAKE**—the strip of water astern of a vessel through which she has passed. The opposite of " grain " (which see).
- WALL-SIDED**—said of a ship with perpendicular sides and high freeboard.

To Warm the bell—to act or arrive before the appointed time ; to be early.

WARP—any rope or hawser used to haul a vessel from one position to another ;
“ to warp ” is to move a vessel by this means. Also a lengthwise thread
in the weave of canvas.

WASH—the disturbance in the water made by the movement of a vessel through
it.

To Wash out—to countermand an instruction or an order. (Derived from the
days when signalmen recorded messages on a slate and expunged them to
enable the recording of new ones.) (See “ belay ”.)

WATER-LOGGED—a vessel is water-logged when she is full of water but still
floating.

WEATHER-BOUND—unable to put to sea owing to the weather.

WEATHER-TIDE—a tidal stream flowing in the opposite direction to the wind
(See “ lee-tide ”.)

To WEEP—to leak slightly ; a weeping cask, or joint in a pipe, for example.

WHARF—a lading place for shipping.

WIND-RODE—a vessel at anchor in tidal waters is said to be wind-rode when
she is swung to the wind rather than to the tidal stream. (See “ tide-rode ”.)

WINDSAIL—a ventilation trunk of canvas slung from aloft with its mouth set
to catch the wind and its foot led below to the space to be ventilated.

To WORK-UP—to train the officers and ship’s company of a newly commis-
sioned ship in their ship’s duties.

APPENDIX II

RIGGING NOTES AND GENERAL DATA

RIGGING NOTES

Strength of Ropes

B.S. = breaking stress in tons ; S.W.L. = safe working load in tons ;
 c = circumference of rope in inches.

(i) CORDAGE

$$\text{Approximately, the B.S.} = \frac{c^2}{3}$$

More accurately :—

$$\text{for rope of 6 in. and under the B.S.} = \frac{c^2}{2.5}$$

$$\text{and for rope of over 6 in. the B.S.} = \frac{c^2}{2.6}$$

$$\text{For general purposes, the S.W.L.} \dots = \frac{\text{B.S.}}{6}$$

A knot in a rope reduces its strength by from 40 to 50 per cent.

A splice in a rope reduces its strength by one-eighth.

(ii) WIRE ROPE

The B.S.s of wire rope are approximately :—

$$\text{for F.S.W.R. of } 4\frac{1}{2}\text{-in. and under} \quad c^2 \times 2$$

$$\text{for F.S.W.R. of over } 4\frac{1}{2}\text{-in.} \quad c^2 \times 2.5$$

$$\text{for S.W.R.} \quad c^2 \times 2.75$$

$$\text{for E.S.F.S.W.R.} \quad c^2 \times 3.6$$

$$\text{For general purposes, the S.W.L.} = \frac{\text{B.S.}}{6}$$

Relative Sizes of Sheaves and Bollards required for ropes

The minimum diameter of a sheave used with wire rope should be not less than six times the circumference of the rope.

The minimum diameter of a bollard used with wire rope should be not less than four times the circumference of the rope.

Factors of Safety (F.S.) for Lifting Appliances

$$\text{F.S.} = \frac{\text{B.S.}}{\text{S.W.L.}}$$

$$\text{For lifts and hoists,} \quad \text{F.S.} = 12$$

$$\text{For running rigging and slings, F.S.} = 8$$

$$\text{For cranes and general purposes, F.S.} = 6$$

Data for Blocks and Tackles rove with Cordage

An ordinary block will take a rope one-third of its size, *e.g.* a 9-inch block will take a 3-inch rope.

A clump block will take a rope half its size.

The strength of a clump block is one-quarter, and of a snatch block is one-third, of the strength of an ordinary block used for the same size of rope.

In a tackle the mechanical advantage (disregarding friction) and the velocity ratio are each equal to the number of parts of the fall at the *moving* block.

To estimate the loss in the mechanical advantage of a tackle due to friction, allow one-tenth of the weight to be lifted for each sheave in the system.

The pull required on the hauling part of a tackle can be calculated from the formula :

$$P = \frac{W (10 + n)}{V \times 10}$$

where :—

P = pull on the hauling part ;

W = weight to be hoisted ;

V = velocity ratio ;

n = number of sheaves in the tackle.

The safe working load of a tackle (factor of safety 8) can be estimated from the following table, in which c is the circumference of the fall in inches.

TACKLE	SAFE WORKING LOAD IN TONS	
	ROVE TO ADVANTAGE	ROVE TO DISADVANTAGE
Single whip	—	$\frac{c^2}{24}$
Gun tackle or double whip	$\frac{c^2}{7.5}$	$\frac{c^2}{12.5}$
Luff	$\frac{c^2}{6}$	$\frac{c^2}{9}$
Two-fold	$\frac{c^2}{5}$	$\frac{c^2}{7}$
Three-fold	$\frac{c^2}{4}$	$\frac{c^2}{5.5}$

Safe Loads for Common Fittings

The safe working load for common fittings can be estimated from the following table, in which "d" is the diameter of the metal measured at a specified part of the fitting.

When a fitting is tested by applying a proof load to it, the load applied is usually twice the safe working load.

Safe Loads for Common Fittings—cont.

FITTING	S.W.L. IN TONS	PLACE WHERE "d" IS MEASURED
Rigging Shackles :— straight bow-shaped, $\frac{1}{2}$ -in. and over bow-shaped, under $\frac{1}{2}$ -in.	$d^2 \times 4$ $d^2 \times 2.5$ $d^2 \times 2$	} at the crown of the shackle.
Rigging slips	$d^2 \times 5$	on the link of the slip.
Chain	$d^2 \times 5$	on the smallest link.
Hooks	$d^2 \div 2$	at the back of the hook.
Eyeplates	$d^2 \times 6$	the metal of the eye.
Eyebolts (driven)	$d^2 \times 5$	the metal of the eye.
Ringbolts	$d^2 \times 2$	the metal of the ring.
Rings :— those with a diameter of the clear four times that of the metal (<i>i.e.</i> the common ring used in the Royal Navy) ... other types of ring	$d^2 \times 2$ $\frac{d^3 \times 9}{D}$	the metal of the ring. where d = diameter of the metal of the ring, and D = mean overall diameter of the ring.

Data for Sheers

The following table is a useful guide to the size of the spars for lifting certain loads when rigged as sheers.

WEIGHT TO BE LIFTED IN TONS	SPARS	
	LENGTH IN FEET	MEAN DIAMETER IN INCHES
3 to 5	30 to 40	11 to 13
5 to 12	40 to 50	13 to 16
10 to 25	50 to 60	16 to 20
25 to 40	60 to 70	24

Buoyancy of Casks

To estimate the weight which an empty cask will support in water, multiply the capacity of the cask in gallons by 10 and the result will be the weight in pounds; *e.g.* a 25 gallon cask will support a weight of 250 lb. in water.

GENERAL DATA

British Weights and Measures

LINEAR MEASURE

	IN.	FT.	YDS.	PLS.	CH.	FS.
Foot	12	1				
Yard	36	3	1			
Rod, pole or perch	198	16½	5½	1		
Chain	792	66	22	4	1	
Furlong	7,920	660	220	40	10	1
Mile	63,360	5,280	1,760	320	80	8

Miscellaneous Measures of Length :—

A fathom = 6 feet.

A cable's length = $\frac{1}{4}$ nautical mile = 202·7 yards or 608 feet.

A degree of latitude varies from 68·7 statute miles at the equator to 69·41 at the Pole.

The following is the length in geographical miles of one degree of longitude at various latitudes :—

at the equator, 69·176 ; at 15° N. or S., 66·832 ; at 30° N. or S., 59·96 ; at 45° N. or S., 48·992 ; at 60° N. or S., 34·676.

A league = 3 nautical miles.

A nautical mile or geographical mile = 2,026½ yards.

A half-penny is one inch in diameter.

SQUARE MEASURE

	SQ. IN.	SQ. FT.	SQ. YDS.	SQ. PLS.	SQ. CH.	SQ. R.
Square foot	144	1				
Square yard	1,296	9	1			
Rod, pole or perch	39,204	272½	30¼	1		
Square chain	627,264	4,356	484	16	1	
Rood	1,568,160	10,890	1,210	40	2½	1
Acre	6,272,640	43,560	4,840	160	10	4

A square mile contains 640 acres = 2,560 square roods = 6,400 square chains = 102,400 square rods, poles or perches = 3,097,600 square yards.

N.B.—The term square feet must not be confounded with feet square. A piece of canvas said to measure 6 square feet, consists of six squares of one foot each, but a piece said to measure 6 feet square would be 6 feet along each side, and comprise thirty-six squares of one foot each.

British Weights and Measures—*cont.***CUBIC MEASURE**

1,728 cubic inches	= 1 cubic foot.
28 cubic feet	= 1 cubic yard.
42 cubic feet timber	= 1 shipping ton.
108 cubic feet	= 1 stack of wood.
128 cubic feet	= 1 cord of wood.

Note.—For computing freight dues on general cargo a shipping ton is, in practice, rated as 40 cubic feet. Cargo may, however, be assessed by weight in tons avoirdupois if this method is to the advantage of the shipping company.

DRY MEASURE

4 gills	= 1 pint.
2 pints	= 1 quart.
4 quarts	= 1 gallon.
2 gallons	= 1 peck.
4 pecks	= 1 bushel.
8 bushels (2 sacks)	= 1 quarter.
26 bushels	= 1 chaldron.

LIQUID MEASURE

4 gills	= 1 pint.
2 pints	= 1 quart.
4 quarts	= 1 gallon.
9 gallons	= 1 firkin.
2 firkins	= 1 kilderkin.
2 kilderkins	= 1 barrel.

AVOIRDUPOIS WEIGHT

27 $\frac{1}{8}$ grains	= 1 drachm = 27.34375 grains.
16 drachms	= 1 ounce = 437.5 grains.
16 ounces	= 1 pound = 7,000 grains.
14 pounds	= 1 stone.
28 pounds	= 1 quarter (qr.).
4 quarters	= 1 hundredweight (cwt.).
20 cwt.	= 1 ton.

This weight is used in almost all commercial transactions and common dealings in the British Commonwealth.

APOTHECARIES FLUID MEASURE (used for medicine)

60 minims (drops)	= 1 fluid drachm.
8 drachms	= 1 oz.
20 ounces	= 1 pint.

Miscellaneous Weights and Quantities

Coal, Wood, Metal, etc. :—

Anthracite, per cubic yard solid	 = 2,160 lb.
Bituminous coal, per cubic yard solid	 = 2,025 „
Cannel, per cubic yard solid	 = 1,400 „
Coal, stored in the usual way, per cubic yard, solid	= 2,160 „

Miscellaneous Weights and Quantities—*cont.**Coal, Wood, Metal, etc., continued. :—*

A cubic foot of fresh water	...	...	weighs	62½ lb.
„ salt water	...	...	„	63½ „
„ timber, ash	...	...	„	49 „
„ „ beech	...	...	„	43 „
„ „ birch	...	...	„	44 „
„ „ cork	...	...	„	15 „
„ „ elm	...	...	„	36 „
„ „ pine	...	...	„	41 „
„ „ oak	...	...	„	59 „
„ clay	...	...	„	125 „
„ loose earth	...	...	„	95 „
A cubic inch of cast iron	...	...	„	0.26 „
„ steel or wrought iron	...	...	„	0.28 „
„ gunmetal	...	...	„	0.31 „
„ lead	...	...	„	0.41 „
„ aluminium	...	...	„	0.097 „
1 ton of anthracite	...	...	averages	25–26 cu. ft.
1 „ household coal	...	...	„	42 „
1 „ coke	...	...	„	82 „
1 „ hard wood (<i>e.g.</i> oak)	...	...	„	40 „
1 „ fir and pitch pine	...	...	„	50 „
1 „ sawn deal planks	...	...	„	65 „
1 „ broken packing cases	...	...	„	220 „

Packing Weights :—

A firkin of butter	...	...	=	56 lb.
„ soft soap	...	...	=	64 „
A barrel of raisins	...	...	=	112 „
„ (or pack) of soft soap	...	...	=	256 „
A sack of potatoes	...	...	=	168 „
„ coals	...	...	=	224 „
„ flour	...	...	=	280 „
A muid of whole mealies	...	...	=	196 „
„ crushed mealies	...	...	=	200 „
A bag of coffee	...	...	=	1½ to 1½ cwt.
„ rice (East India)	...	...	=	about 1½ cwt.
A bale of coffee (Mocha)	...	...	=	2 to 2½ cwt.
A barrel of beef	...	...	=	200 lb.
„ butter	...	...	=	224 „
„ gunpowder	...	...	=	100 „
„ tar	...	...	=	26½ gallons
A bushel of coal...	...	...	=	80 lb.
A cask of rice (American)	...	...	=	6 cwt.
A chaldron of coke	...	...	=	36 bushels.
A chest of tea	...	...	=	about 84 lb.
One gross	...	...	=	12 dozen.
A hogshead of sugar	...	...	=	13 to 16 cwt.
A loaf, quartern...	...	...	=	4 lb.

Miscellaneous Weights and Quantities—cont.*Packing Weights, continued. :—*

A tierce of coffee	...	...	...	...	= 5 to 7 cwt.
„ sugar	...	...	...	...	= 7 to 9 „
A tub of butter	...	...	...	...	= 84 lb.

Mensuration of Surfaces and Solids

Circumference of a circle = diameter $\times$ 3.1416.

Area of a triangle = base $\times$ perpendicular $\div$ 2.

Area of a square or oblong = length $\times$ breadth.

Area of a circle = diameter² $\times$ 0.7854, or radius² $\times$ 3.1416.

Area of sector of circle = length of arc $\times$ radius $\div$ 2.

Area of any right-lined figure of four or more unequal sides is found by dividing it into triangles, finding the area of each, and adding together.

Area of an ellipse = long axis $\times$ short axis $\times$ 0.7854.

Surface of prism or cylinder

= (area of two ends) + (length $\times$ perimeter).

Surface of cone or pyramid

= $\frac{1}{2}$ (slant height $\times$ perimeter of base) + area of base.

Surface of cube = sum of areas on all the sides.

Surface of sphere = square of diameter $\times$ 3.1416.

Cubic content of prism or cylinder = area of base $\times$ height.

Cubic content of cone or pyramid

= $\frac{1}{3}$ (area of base $\times$ perpendicular height).

Cubic content of cube = length $\times$ breadth $\times$ depth.

Cubic content of sphere = cube of diameter $\times$ 0.5236.

Comparison Table for Water, Petrol and Oil

	FRESH WATER	PETROL		OIL	
		AVIATION	M.T.	MINERAL	CASTOR
1 Gallon = (lb.)	10	7.2	7.35	9.00	9.63
Specific Gravity	1.00	0.722	0.735	0.900	0.963
1 Ton = (galls.)	224	311	305	248	233
1 Ton = (cu. ft.)	36	49.8	50	40	37.4

Fresh Water—volume and weight

One Imperial gallon = 277.274 cubic inches = 0.16 cubic feet = 10 lb. = 4.537 litres.

One U.S. gallon = 231 cubic inches = 0.133 cubic feet = 8.33 lb. = 0.83 Imperial gallon = 3.8 litres.

One cubic inch = 0.03607 lb. = 0.003607 Imperial gallon.

One cubic foot = 6.23 Imperial gallons = 28.375 litres = 0.283 cubic metre = 62.35 lb.

One lb. = 27.72 cubic inches = 0.10 Imperial gallon = 0.4537 kilo.

One cwt. = 11.2 Imperial gallons = 1.8 cubic feet.

The weight of fresh water is to that of sea water as 1 : 1.026.

Conversion Factors for various Measures and Weights

TO CONVERT	INTO	MULTIPLY BY
C° ...	F° ...	$(F° - 32) \times \frac{5}{9}$
Centimetres ...	inches ...	0.3937
Cubic centimetres ...	cubic inches ...	0.061
Cubic feet ...	cubic metres ...	0.0283
Cubic inches ...	cubic centimetres ...	16.39
Cubic inches ...	litres ...	0.0164
Cubic metres ...	cubic feet ...	35.31
Cubic metres ...	cubic yards ...	1.308
Cubic yards ...	cubic metres ...	0.7646
F° ...	C° ...	$(C° \times \frac{9}{5}) + 32$
Feet ...	metres ...	0.305
Feet per min. ...	miles per hour ...	0.01137
Feet per sec. ...	miles per hour ...	0.682
Feet per sec. ...	metres per min. ...	18.288
Force de cheval ...	horse-power ...	0.986
Gallons ...	litres ...	4.546
Gallons (water) ...	cubic feet ...	0.161
Grams ...	ounces ...	0.03527
Horse-power ...	force de cheval ...	1.014
Imperial gallons ...	U.S. gallons ...	1.205
Inches ...	centimetres ...	2.5399
Inches ...	feet ...	0.0833
Inches ...	metres ...	0.0254
Inches ...	millimetres ...	25.4
Inches ...	yards ...	0.0277
Kilograms (1,000 grms.) ...	lbs. ...	2.205
Kilograms ...	ounces ...	35.27
Kilometres ...	miles ...	0.621
Knots ...	miles per hour ...	1.151
Lb. (7,000 grms.) ...	kilograms ...	0.454
Litres ...	cubic inches ...	61.0
Litres ...	gallons ...	0.220
Litres ...	pints ...	1.76
Metres ...	feet ...	3.28
Metres ...	inches ...	39.37
Metres ...	yards ...	1.094
Metres per min. ...	feet per sec. ...	0.0547
Metres per sec. ...	m.p.h. ...	2.24
Miles ...	kilometres ...	1.609
Miles per hour ...	feet per min. ...	88.0
Miles per hour ...	feet per sec. ...	1.467
Miles per hour ...	knots ...	0.868
Miles per hour ...	metres per sec. ...	0.447
Millimetres ...	inches ...	0.039
Ounces ...	grams ...	28.35
Ounces ...	kilograms ...	0.02835
Pints ...	litres ...	0.568
Square centimetres ...	square inches ...	0.155
Square feet ...	square metres ...	0.0929
Square inches ...	square centimetres ...	6.4516
Square kilometres ...	square miles ...	0.3862
Square metres ...	square feet ...	10.76
Square metres ...	square yards ...	1.197
Square metres ...	square kilometres ...	2.589
Square yards ...	square metres ...	0.8361
Tonnes ...	tons ...	0.9842
Tons ...	tonnes ...	1.016
U.S. gallons ...	Imperial gallons ...	0.830
Yards ...	metres ...	0.914

Comparisons between the British and Metric Systems of Weights and Measures

The metric system is used in the Argentine Republic, Austria, Belgium, Bolivia, Brazil, Bulgaria, Chili, Colombia, Costa Rica, Czechoslovakia, Ecuador, France, Germany, Greece, Hayti, Hungary, Italy, Netherlands, Norway, Poland, Portugal, Rumania, San Domingo, Yugoslavia, Soviet Russia, Spain, Switzerland, Sweden, Turkey, United States (partially) and Venezuela.

LINEAR MEASURE

British	Metric
1 inch = 25·4 millimetres.	1 millimetre = 0·039 in.
1 foot = 0·305 metre.	1 centimetre (10 mm.) = 0·394 in.
1 yard = 0·9144 metre.	1 decimetre (10 cm.) = 3·937 in.
1 mile = 1·609 kilometre.	1 metre (10 dm.) = 3·281 ft.
	1 kilometre (10 hm.) = 0·621 mile.

SQUARE MEASURE

1 sq. in. = 6·451 sq. centimetres.	1 sq. centimetre = 0·155 sq. in.
1 sq. yd. = 0·836 sq. metre.	1 sq. metre. = 1·196 sq. yd.

CUBIC MEASURE

1 cu. in. = 16·387 cu. centimetres.	1 cu. centimetre = 0·061 cu. in.
1 cu. ft. = 0·028 cu. metre.	1 cu. decimetre = 61·024 cu. in.
1 cu. yd. = 0·764 cu. metre.	1 cu. metre = 13·08 cu. yd.

MEASURES OF WEIGHT

1 lb. = 0·454 kilograms.	1 gram = 0·035 oz.
1 ton = 1·0169 kilograms.	1 kilogram = 2·204 lb.

MEASURES OF CAPACITY

1 pint = 0·568 litre.	1 litre = 1·759 pints.
1 gallon = 4·546 litres.	1 hectolitre = 21·997 gallons.

Approximate Conversion Factors for Certain British and Metric Measures and Weights

The following factors will be found useful when approximations only are required of moderate quantities :—

Gallons to litres :	multiply by $4\frac{1}{2}$.
Kilometres to miles :	multiply by $\frac{5}{8}$.
Kilos to pounds :	multiply by $2\frac{1}{4}$.
Metres to yards :	add $\frac{1}{10}$.
Pounds to kilos :	multiply by $\frac{2}{3}$.
Tonnes to tons :	multiply by $\frac{9}{10}$.
Tons to tonnes :	multiply by $\frac{102}{100}$.
Yards to metres :	deduct $\frac{1}{10}$.

For converting petrol and oil gallons to tons :—

$$\frac{\text{Petrol gallons}}{300} = \text{tons.}$$

$$\frac{\text{Oil gallons}}{240} = \text{tons.}$$

Comparison Tables of Measures of Length

BRITISH AND METRIC UNITS OF LENGTH

GEOGRAPHICAL MILE	NAUTICAL MILES	STATUTE MILES	KILOMETRES	FURLONGS	FATHOMS	METRES	YARDS	FEET	INCHES	CENTIMETRES
1	1.0012	1.1529	1.8554	9.223	1,014.5	1,855.4	2,029.1	6,087.2	73,046	185,537
—	1	1.1515	1.8532	—	1,103.3	1,853.2	2,026.6	6,080	72,960	185,318
—	—	1	1.6093	8	880	1,609.3	1,760	5,280	63,360	160,934
—	—	—	1	4.97	546.8	1,000	1,093.6	3,280.8	39,270	100,000
—	—	—	—	1	110	201.2	220	660	7,920	20,117
—	—	—	—	—	11	20.12	22	66	792	2,012
—	—	—	—	—	1	1.829	2	6	72	183
—	—	—	—	—	—	1	1.0936	3.281	39.37	100
—	—	—	—	—	—	—	1	3	36	91.44
—	—	—	—	—	—	—	—	1	12	30.48
—	—	—	—	—	—	—	—	—	7.92	20.12
—	—	—	—	—	—	—	—	—	1	2.54

Comparison Tables of Measures of Length—cont.**MILES, KILOMETRES AND SEA MILES**

MILES	KILO- METRES	SEA MILES	MILES	KILO- METRES	SEA MILES
0.621	1.0	0.539	24.86	40.0	21.56
1.0	1.609	0.8684	25.0	40.233	21.71
1.1515	1.853	1.0	27.967	45.0	24.256
1.246	2.0	1.078	28.77	46.329	25.0
1.864	3.0	1.617	30.0	48.27	26.052
2.0	3.219	1.736	31.075	50.0	26.95
2.253	3.706	2.0	34.545	55.594	30.0
2.486	4.0	2.156	35.0	56.31	30.39
3.0	4.828	2.605	37.29	60.0	32.34
3.107	5.0	2.695	40.0	64.37	34.736
3.454	5.559	3.0	40.302	64.859	35.0
3.729	6.0	3.234	43.505	70.0	37.73
4.0	6.437	3.473	45.0	72.415	39.07
4.350	7.0	3.773	46.062	74.125	40.0
4.606	7.412	4.0	49.72	80.0	43.12
4.972	8.0	4.312	50.0	80.464	43.42
5.0	8.047	4.342	52.8	83.39	45.0
5.593	9.0	4.851	55.935	90.0	48.51
5.757	9.265	5.0	57.575	92.656	50.0
6.0	9.645	5.21	60.0	96.55	52.104
6.215	10.0	5.39	62.15	100.0	53.9
6.909	11.118	6.0	69.09	111.187	60.0
7.0	11.265	6.078	70.0	112.65	60.788
8.0	12.874	6.947	77.685	125.0	67.375
8.06	13.172	7.0	80.0	128.74	69.472
9.0	14.484	7.815	80.605	129.718	70.0
9.212	14.824	8.0	90.0	144.38	78.156
9.322	15.0	8.085	92.12	148.249	80.0
10.0	16.09	8.684	93.225	150.0	80.85
10.363	16.878	9.0	100.0	160.92	86.84
11.515	18.531	10.0	103.635	166.781	90.0
12.43	20.0	10.78	108.762	175.0	94.325
15.0	24.140	13.02	110.0	177.02	95.524
15.537	25.0	13.475	115.15	185.312	100.0
17.272	27.797	15.0	124.301	200.0	107.8
18.645	30.0	16.17	125.0	201.16	108.55
20.0	32.18	17.368	139.8	225.0	121.27
21.752	35.0	18.865	143.9	231.6	125.0
23.030	37.062	20.0	150.0	241.35	130.26

Roman Numerals

XL = 40 ; L = 50 ; LXXXIX = 89 ; XC = 90 ; XCIX = 99 ; C = 100 ; CXC = 190 ; CC = 200 ; CCC = 300 ; CD = 400 ; D = 500 ; DC = 600 ; DCCC = 800 ; CM = 900 ; M = 1,000 ; MM = 2,000.

Sound—Rate of Travel and Distance of Source

Sound travels at 380 yards per second. For roughly estimating the distance from you of the source of any sound, it can be taken that your normal pulse will beat four times for every 1,000 yards the sound travels.

Comparison Tables of Measures of Length—cont.**FEET AND METRES**

METRES	FEET	METRES	FEET
1	3·280	3,000	9,842·4
2	6·561	3,500	11,482·8
5	16·404	4,000	13,123·2
10	32·809	4,500	14,763·2
50	164·04	5,000	16,404·0
100	328·09	5,500	18,044·4
250	820·14	6,000	19,684·8
500	1,640·4	6,500	21,325·2
1,000	3,280·8	7,000	22,965·6
1,500	4,921·2	7,500	24,606·0
2,000	6,561·0	8,000	26,446·4
2,500	8,201·4		

Conversion of Fahrenheit to Centigrade

To convert Fahrenheit to Centigrade, deduct 32 and multiply by $\frac{5}{9}$. To convert Centigrade to Fahrenheit, multiply by $\frac{9}{5}$ and add 32.

CENTI- GRADE	FAHREN- HEIT	CENTI- GRADE	FAHREN- HEIT	CENTI- GRADE	FAHREN- HEIT
—0	32·0	21	69·8	41	105·8
+1	33·8	22	71·6	42	107·6
2	35·6	23	73·4	43	109·4
3	37·4	24	75·2	44	111·2
4	39·2	25	77·0	45	113·0
5	41·0	26	78·8	46	114·8
6	42·8	27	80·6	47	116·6
7	44·6	28	82·4	48	118·4
8	46·4	29	84·2	49	120·2
9	48·2	30	86·0	50	122·0
10	50·0	31	87·8	55	131·0
11	51·8	32	89·6	60	140·0
12	53·6	33	91·4	65	149·0
13	55·5	34	93·2	70	158·0
14	57·2	35	95·0	75	167·0
15	59·0	36	96·8	80	176·0
16	60·8	37	98·6	85	185·0
17	62·6	38	100·4	90	194·0
18	64·4	39	102·2	95	203·0
19	66·2	40	104·0	100	212·0
20	68·0				

APPENDIX III

Questions

THE questions in this appendix are intended only to give the candidate for examination a guide to the type of question which may be asked, and a general idea of the knowledge which he is expected to possess ; they are not intended for use as standard or stock questions for examinations. Reference to the text of the relevant chapter will enable the reader to answer every question correctly.

For those chapters whose scope covers several subjects the questions have, for ease of reference, been grouped under the same headings as the text to which they refer ; and for all chapters the questions are given in the same progressive sequence as is the information in the chapter to which they refer.

The extent of knowledge required by a candidate in any particular subject will be found in the syllabus for the examination which he is taking ; the syllabuses for all examinations in seamanship held in the Royal Navy are published from time to time in *Admiralty Fleet Orders*.

CHAPTER I

SHIP RECOGNITION

Warships

1. What are the main principles of warship recognition ?
2. How are warships classified for recognition purposes ?
3. At a distance, or in low visibility, how would you distinguish the various types of warship ?
4. What are the general features of each type of warship ?
5. Having recognised the type of a warship, what further means of identification are possible ?

Merchant Ships

6. When identifying a merchant ship, what features are noted when viewed at :—(a) long range, (b) medium range, and (c) close range ?
7. Taking a specific merchant ship as an example, write notes on what is necessary for her identification.
8. In addition to these noted features, what other means of identifying her are possible.

CHAPTER II

SHIP SAFETY

1. What do the terms " ship safety " and " damage control " cover ?
2. What are the main objects of damage control ?
3. What are the principal types of damage which a ship may sustain ?
4. What is the object of compartmentation in a ship ?
5. What is the datum deck ?

6. What is the difference between the meaning of a "red" and a "blue" marking on a water-tight fitting?
7. Give as many examples of water-tight fittings as you can.
8. What is the emergency order for making a ship as water-tight as possible?
9. In what sequence are water-tight openings closed?
10. What are the recognised basic water-tight markings?
11. What does each marking signify?
12. What are "qualifying symbols", and why are they used? Name as many as you can remember.
13. What are "identification markings", and where are they found?
14. What is a scupper, what is a drain pipe?
15. What detail about pumps and pumping systems is it important to remember?
16. What is the purpose of a safety lamp, and how is it used?
17. What are the chief dangers of a forced ventilation system?
18. What precautions are taken to guard against these dangers?
19. What do you know about secondary lighting?
20. Why is the correct stowage of kit, stores and damage control equipment so important?
21. What do you know about flash, shock, splinters and gas masks, and the precautions in relation to them?
22. Where is your knife now, at this moment? Tie a reef knot and a bowline.
23. What is a main dressing station and what is a first-aid post?
24. What markings would you expect to find on a main transverse bulkhead?
25. To whom would you report an outbreak of fire in your ship:
 - (a) when at sea?
 - (b) when in harbour?
26. What are the dangers of indiscriminate smoking?
27. Why should locker doors be fastened?
28. Why should not valves, rod gearing and similar equipment be used as clothes pegs? Where would you *not* sling your hammock?
29. What is the object of lashing a hammock tautly and stowing it in a hammock bin?
30. What precautions should you take before locking up a store room or a compartment?
31. If secondary lighting lamps are placed conveniently near your slinging billet why should you not use them for reading by?
32. How far can the following be seen on a dark clear night :—
 - (a) a lighted match?
 - (b) a lighted cigarette?
 - (c) an unmasked torch?
33. What is the danger in wartime of the indiscriminate "ditching" of "gash".
34. In war what personal equipment should you always keep handy for immediate use?
35. What precautions should you take when closing a water-tight door or hatch?
36. What maintenance do the following fittings in water-tight doors, hatches and ports require :—
 - (a) rubbers?
 - (b) bearing surfaces?

- (c) clips ?
- (d) hinges ?
- 37. How should you stow a fire hose ?
- 38. How should you dispose of an empty fire extinguisher ?
- 39. When would you leave your post of duty ?
- 40. What happens on the order, " Hands to emergency stations " ?
- 41. When the order " Abandon ship " is given, how would you leave the ship ?

CHAPTER III

FIRE-FIGHTING

1. What three elements combined make a fire ?
2. What are the three principal methods of extinguishing a fire ?
3. What immediate action would you take on discovering a fire ?
4. What are the disadvantages of using water indiscriminately for fighting fires ?
5. Why should not water be used on electrical apparatus ?
6. How would you attack a fire in a smoke-filled compartment ?
7. If a fierce fire is burning in a compartment, what precautions would you take in regard to adjacent compartments ?
8. Describe the operation of the three types of hand extinguishers supplied in the Navy. Give examples of when each should be used.
9. How many hoses can be used simultaneously off the firemain in normal circumstances ? How can this number be increased effectively ?
10. What precautions should be taken in the care and maintenance of hoses ?
11. Describe the operation of a foam unit.
12. What are the fixed fire-fighting systems of a ship ?
13. What types of breathing apparatus are supplied for fire-fighting in ships ? Describe briefly how each is used.
14. What are the disadvantages of using a Service anti-gas respirator for fighting fires ?
15. Describe how you would tackle the following types of fire :—structural and general fires ; fire in a shell room ; petrol fire ; hangar fire ; electrical fire ; cinema film fire.

CHAPTER IV

INTERNAL ORGANISATION

Voice Communication

1. What are the general rules for all methods of voice communication ?
2. What are the important points to bear in mind when receiving a verbal message for transmission ?
3. How do you answer a telephone call ?
4. Can telephone conversations be overheard by others ?
5. How do you call up anyone on a voice-pipe ?
6. Demonstrate your ability to broadcast a pipe.
7. How is an alarm signal broadcast ?

Organisation

8. Describe the watch systems used in the Royal Navy.
9. What is the difference between "watch of the hands" and "watch for exercise"? Of whom do the "duty hands" consist?
10. What is the relation between a "part of a watch" and a "part-of-ship"?
11. What is the "Watch and Station Bill"?
12. Describe the various "degrees of readiness".
13. What do you know about the "divisional system"?
14. What is the sequence of duty watches or duty parts of watches at sea and in harbour when the ship is organised (a) in three watches; and (b) in two watches?
15. What specific duties may the "duty part of the watch" be expected to carry out in harbour?
16. What specific duties may be carried out at sea by the "watch on deck"?
17. Name as many evolutions as you can under the following headings:—
(i) for all hands, (ii) for a watch or watches, (iii) for a part of a watch.
18. Name as many routine duties for petty officers as you can.
19. Name as many special duties for petty officers as you can.
20. What is a "special dutyman"? Name as many special duties or parties as you can.
21. What is the "excused list"?
22. What are the duties carried out by "special sea dutyman"? What is the difference between "special sea dutyman" and "sea dutyman"?
23. What are the duties of the "cable party"?
24. What is a "watchkeeper"? What are the duties of the "guard"?
25. How are chief and petty officers and other ratings allocated to messes?
26. Describe the difference between "cafeteria" and "general messing".
27. Name as many offices as you can, and describe their functions.
28. What would you expect to find in a copy of a ship's daily orders?

Messing, Provisions and Stores

29. Name and describe the various messing systems in use in the Royal Navy.
30. What is "victualling allowance"?
31. What is "cash victualling"?
32. What does the term "provisions on repayment" mean? What provisions are included in this term?
33. What is the weekly routine in your ship for the issue of provisions?
34. What stocks of provisions are maintained on board a battleship, a cruiser and a destroyer?
35. How are the following provisions supplied or packed? Sugar, haricot beans, mustard, vinegar, rice, oatmeal, jam.
36. How can you tell the difference between a cask of rum and a cask of vinegar?
37. What are "wet provisions" and what are "dry provisions"?
38. In what categories are mess traps and clothing designated? How are they supplied?
39. What is a "naval store"? How are naval stores classed?
40. What is a "survey", and what occurs at a survey?

41. What is done with an article which is categorised as (a) condemned, and (b) repairable?
42. Name the various store rooms and provision rooms in your ship and give instances of the articles stored in each.
43. What are the general rules for the proper stowage of stores?
44. Where are the following liquids stowed in your ship? Sacramental wine, rum, paraffin, paint, lubricating oil.
45. How can you distinguish a drum holding an inflammable liquid from one holding a non-inflammable liquid?
46. From which departments of a Royal Dockyard are the following articles drawn? (a) clothing, (b) vegetables, (c) wet provisions, (d) flour, (e) cordage, (f) canvas, (g) awnings, (h) hawsers, (i) wire rope, (j) rum, (k) timber, (l) mess traps, (m) kit lockers.
47. What arrangements would you make for provisioning your ship? Where would you stow (a) potatoes, (b) fresh fruit and (c) cheese?
48. How would you stow a cask? What is the maximum number of tiers allowed for the stowage of hogsheads? Name the parts of a cask. How many gallons does a barrel hold?
49. Why should not a broached container be stowed with whole ones?

CHAPTER V

ROPE AND ITS USAGE

Work in Cordage

1. What are the different types of seizing, and where could they be used?
2. How is a heaving mallet used?
3. How is a Spanish windlass used?
4. What is the relation between the size of a seizing and the size of the ropes on which it is used?
5. Where would the following be used :—cut splice, chain splice, Flemish eye, grommet and becket? Demonstrate each answer.
6. How is a rope wormed, parcelled and served?
7. Why is a rope wormed, parcelled and served, and what precaution is necessary with a rope so fitted?
8. Demonstrate the following knots, and give instances where they would be used :—manrope knot; Turk's head—standing, running and on the bight; double Matthew Walker; stopper knot; monkey's fist; heaving line knot; sennet knot; double diamond knot.
9. Demonstrate the following, and give instances of the use of each one :—pointing, grafting, coach whipping, half hitching, continuous walling, ringbolt hitching.
10. Describe how a cargo net is made?

Wire Rope Splicing

11. Demonstrate the following wire rope splices :—short splice, long splice, and eye splice.
12. How is a large wire rope broken in around a thimble?
13. How is a grommet strop made?
14. How is the strength of a grommet strop calculated?

15. Where is a reduced eye used, and how is it made? What is the strength of a reduced eye in comparison with that of the rope?
16. How is cordage spliced into wire rope, and where would this be necessary?

Hawsers and their Handling

17. What is the difference between a hawser, a berthing hawser and a hurricane hawser?
18. What is the length of a fibre hawser, and a wire hawser?
19. How would you bend a heaving line to the bollard eye of a berthing hawser, and a messenger to the hawser eye of a hawser?
20. When a wire hawser is belayed to a single bollard, why should the end be seized to the hauling part?
21. When securing two or more berthing hawsers to a single bollard, how should their bollard eyes be placed over the bollard, and what is the reason for this?
22. How are the turns of a wire hawser racked when belayed to twin bollards?
23. How is a towing hawser belayed to twin bollards?
24. What is the difference between a rope stopper, a chain stopper, a chain check stopper and a Carpenter's stopper, and where would each be used?
25. When using a rope or a chain stopper, how is the loss of slack avoided when the hawser is belayed?
26. How is a heavy hawser controlled when being paid out?
27. What roughly is the holding effect of the turns of a wire hawser round a bollard?
28. Name the berthing hawsers of a ship secured alongside a jetty.
29. What attention should always be given to a wire hawser as it is being reeled up?
30. How is the end of a wire hawser secured to the spool of its reel?

Types, Characteristics, and Maintenance of Rope

31. Why is acid harmful to wire hawsers? What lubricant would you use for a wire hawser?
32. How can the different types of cordage supplied to the Royal Navy be distinguished?
33. Place cordage made of Italian hemp, sisal, manila, and coir in their order of precedence in regard to their strength, weight, flexibility and wearing qualities.
34. Place the following types of cordage in their order of precedence in regard to strength :—cable-laid rope, hawser-laid rope, shroud-laid rope, bolt-rope, stage lashing, and spunyarn.
35. What are junk and rumbo?
36. What is the difference in construction of signal halyard, log line and lead line?
37. For what purposes are the following small stuffs used :—twine, mackerel line, marline and nettlestuff?
38. What is the jaw of a rope?
39. What are the main differences between hard and soft laid ropes?
40. When estimating the fitness of a rope for any purpose what feature should be examined?

41. Before deciding to turn a boat's fall end for end, what special features should be looked for?
42. What are :—Lang's lay ; preformed rope ; composite rope ?
43. What are tulips, sockets, swaged ends, and Bordeaux connections, and where would you expect to find them ?
44. How would you distinguish a 3-inch S.W.R., a 3-inch F.S.W.R., and a 3-inch E.S.F.S.W.R. from each other ?
45. What is the relative flexibility of a 3-inch 6×12 F.S.W.R. to a 3-inch 6×37 E.S.F.S.W.R., and a $\frac{1}{2}$ -inch 6×19 E.S.F.S.W.R. to a 2-inch 6×12 F.S.W.R. ?
46. What is the " factor of safety ", and what is its value for hoists, running rigging, slings, and hawsers ?
47. What is the general relationship between the diameter of a sheave and the life of the wire rope working around it ?
48. If a lift rope showed signs of undue wear, what would be the probable causes ?
49. If a 4-inch F.S.W.R. is led round a shackle bolt of 2-inch diameter, what stress would you expect the rope to withstand ? Does the strength of the rope decrease the further it is bent around the bolt ?
50. In what way would a wire rope show signs of strain ? When estimating the fitness of a wire rope for any purpose, what features should be examined ?
51. How often should wire ropes of hoists be examined ? What is the signification of a broken wire in the rope of a hoist ?
52. What effect, if any, does extreme cold have on wire rope ?

CHAPTER VI

RIGGING

Miscellaneous Rigging

1. What is a " rigging warrant ", what is its purpose, and what items are included in it ? Where are details of a ship's hawsers and awnings to be found ?
2. Describe how dressing lines are rove in your ship.
3. Describe how guardrails are fitted and rove.
4. Describe how shrouds are rattled down. What is the use of a sheerpole ?
5. Describe how you would send down a slung yard.
6. Describe how you would cross a yard to a mast.
7. Describe how you would strike a fidded topmast.
8. How would you unship the lower boom of your ship and stow it inboard ?
9. How is a telescopic mast housed ?
10. What different types of ladder are provided in H.M. ships ? Describe, with the aid of a sketch, a warship's accommodation ladder and its rigging. What are tide spars and how are they rigged ? What is a guest warp ?
11. State what you know of the principles of fendering. Describe the various fenders in common use at sea, and give examples of where each may be used.

12. Demonstrate how you would rig and sling a stage for painting the ship's side, and a bosun's chair on a gantline. How would you rig stages for painting a cruiser's funnel?
13. Demonstrate how you would fish a destroyer's lower boom which has been broken at its middle.

Awnings

14. Describe the parts of an awning, also the method of rigging a small awning, and a tented awning.
15. Describe the uses and rigs of awning curtains, side screens and gable ends.
16. How would you spread and furl a small awning in a strong breeze?
17. How is a tented awning usually spread? How would you furl a tented awning in a strong wind?
18. What are the "fixed points" of an awning, and what is their importance when spreading an awning? State what you know about the care and maintenance of awnings.

Sailmaking

19. Describe the elastic properties of canvas and its limitations. How would you paint a canvas guardrail screen, and a canvas reel cover?
20. How is canvas supplied? What is the purpose of the coloured lines in canvas? What types of canvas are supplied to H.M. ships, and for what purpose is each used?
21. What tools are required for sailmaking and what is the purpose of each? What are the three chief methods of sewing canvas, and for what is each used?
22. Demonstrate your ability to sew two pieces of canvas together, and to repair a cornered rent in a piece of canvas. Demonstrate your ability to fit an eyelet in canvas.

Derricks

23. Describe, with the aid of a sketch, the rigging of a merchant ship's derrick. How is a snottier used?
24. Describe the working of a derrick by the union purchase method. What is a "deadman" and how is it used?
25. Where would you find the markings for the safe working load of a hoisting system used in H.M. ships? Are the proof or safe working loads of the component parts of such hoisting systems marked on those parts? If not, why not?
26. How is a derrick of one of H.M. ships tested?
27. How would you find the lifting capabilities of a cruiser's crane?
28. What maintenance and tests are required for cranes?

Slinging

29. State what you know of the principles governing the slinging of loads.
30. What is the safe working load of a four-legged sling made of 2-inch F.S.W.R.?
31. What is the approximate safe working load of a cordage provision net, and of a wire rope provision net?

Extempore Derricks

32. What are the chief differences between a standing derrick, a swinging derrick, sheers, and a gyn?
33. How would you rig a standing derrick, a swinging derrick, sheers and a gyn?

Strengths of Rigging Fittings and Gear

34. When estimating the pull required on the hauling part of any particular tackle what allowance would you make for friction?
35. The eyebolt to take the upper block of a tackle is tested to 2 tons and you want to lift a weight of 18 cwt. on it; what tackle would you use and how would you reeve it?
36. You wish to lift a weight of 2 tons with two men; what tackle would you use?
37. What is the safe lifting load of a $3\frac{1}{4}$ -inch luff: (a) when rove to advantage? and (b) when rove to disadvantage?
38. How would you prevent turns from forming in a tackle?
39. Demonstrate how you would reeve a three-fold purchase.

Geared Blocks

40. What advantages have geared blocks over tackles? Name the different types of geared blocks in common use at sea and give examples of the use of each.

Estimation of Stress

41. If you are told to rig a swinging derrick for a safe working load of 12 tons, for what loads would you provide at the attachment points of the various blocks if the derrick were rigged (a) with a single whip, and (b) with a double whip?

CHAPTER VII

BOATWORK

1. As coxswain of a boat what navigational information would you ask for if ordered to go to a strange landing place? What signals should you always be able to identify when away in a boat? What details of the boat's equipment would you check when getting under way?
2. Why is a person not allowed to place his arm or hand on the gunwale of a boat?
3. Why should not a boat be hauled ahead from an inner billet when casting off from the lower boom in a tideway?
4. When a boat is unhooked from, or hooked on to, her falls, which fall is hooked on first, and which is unhooked first? Give the reason in each case.
5. Why should the bows of a ship anchored in a tideway be given a wide berth? Describe how you would make your boat fast alongside a ship's ladder in a tideway.
6. What is the maximum number of persons which may be carried in a cutter and a whaler (a) in calm weather, and (b) in rough weather?

7. When loading your boat with stores how would you stow them? What precautions would you take if ordered to bring off a valuable package?
8. Describe how you would anchor your boat (a) on a sandy bottom in 2 fathoms, (b) on a rocky bottom in 3 fathoms, and (c) off a steeply shelving beach when the boat is to be left unattended. If your boat is anchored in a rough sea and snatching at her cable, what would you do?
9. Describe how you would make your boat fast to a lower boom, and what details you would attend to before allowing the crew to leave her. What details would you attend to after your boat is hoisted inboard?

Stowage of Boats

10. What precautions should be taken when pitching a boat?
11. Describe how you would stow a boat whose crutches are not available.
12. Describe the three main types of boats' davits in general use.
13. What extra davit fittings and gear are required for a seaboat? How would you turn in a boat hoisted at radial davits?
14. Describe the fittings of hinged davits.
15. How are the seaboat's falls rove in your ship, and what is the length and size of each fall? When are a boat's falls renewed or turned end for end? When inspecting a boat's falls what details would you look for?

Slinging, Lowering, Hoisting, and Securing Boats

16. What is the difference between a boat's hull slings and purchase slings? Describe the methods of slinging: (a) a boat hoisted at davits, (b) a round-bilge boom-boat, and (c) a hard-chine boom-boat. What is a Robinson's common hook and where is it used? What is a spreader sling used for, what is its purpose, and how is it marked? When are a boat's slings fitted, and who fits them? When a boat is returned to store should her slings be returned with her?
17. Describe briefly the operation of Robinson's disengaging gear. Demonstrate your ability to set up the disengaging gear of a seaboat.
18. Describe how you would rig and equip a seaboat.
19. As coxswain of a seaboat what details would you check when taking over your duties, and what report would you make? How would you secure the boat-rope, and what are its uses? Why is the tiller of a seaboat stopped towards the side of the boat next to the ship? How would you tell the difference between a port and a starboard seaboat? How would you prevent turns from forming in the falls as the boat is hoisted or lowered? Is there any need to take the turns out of a seaboat's fall before it is hooked on? Why is nobody allowed before the foremost fall, or abaft the after fall, when a boat is being hoisted or lowered? When a boat is being lowered in a seaway how is she prevented from surging, and from swinging towards or away from the ship's side?
20. Describe the drills for hoisting and lowering a boat at davits in harbour. Describe the drills for hoisting and lowering a seaboat at davits.
21. How would you hoist a swamped boat?
22. Describe how a boom-boat is hoisted in and out in rough weather.

Boat Sailing

25. Demonstrate your ability to instruct the crew of a whaler in sail drill.

26. What are the differences between close-hauled, reaching, and running? When is a boat sailing free? When is a boat on the port tack, and when is she on the starboard gybe? What do the following terms mean: to miss stays, to be in irons, to bear up, to keep away, to luff, lee helm, to pinch, and to settle?
27. Why is the trim of a sailing boat so important? Why is it inadvisable for a boat to carry lee helm? How would you correct lee helm? How would you trim your boat when running, reaching, and beating?
28. Describe how you would tack, and wear, in a whaler. If your boat is "slack in stays" (*i.e.* sluggish in going about) how would you guard against missing stays? If your boat gets in irons what would you do? When would you use your bearing-out spars? Why should you avoid running dead before the wind in a rough sea? What would you do if your boat is struck by a squall when reaching, running, and beating? Describe how you would take down a reef in a whaler's mainsail.
29. What is the object of a drop keel? In what position would you have your drop keel when running, reaching, beating, and approaching shoal water?
30. Describe how you would get a whaler under way from alongside a ship's ladder, and from the lower boom. Describe how you would go alongside the ladder of a ship swung head to wind. Describe how you would go alongside a landing place down wind.
31. What would you do if one of your crew falls overboard when reaching or running in a whaler.
32. What is a sea anchor? When and how is it used?
33. Describe how you would heave to in a whaler.
34. How would you stretch a new suit of sails? What care should be given to a boat's sails? How would you bend a whaler's mainsail to its yard, and her mizzen to its mast and boom? How would you lace the luff of a mainsail to the mast?
35. How are boats' sails marked?

Handling of Power Boats

36. How is the direction of rotation of a power boat's propellers described?
37. What is the maximum rudder angle of a power boat?
38. Why is it inadvisable to use full rudder at full speed in a heavily laden boat? Why should passengers and stores be distributed amidships in a boat?
39. What are the dangers of running before a heavy swell? When going alongside a ship anchored in a strong tideway why should you avoid overshooting her accommodation ladder? How would you secure your boat alongside a landing place? Describe the uses of head and back springs when going alongside or leaving a landing place. How would you know if your boat was running into shoal water? Why should you avoid taking your boat into muddy or sandy water? Describe how you would take in tow: (a) a cutter full of libertymen, and (b) a number of pulling boats. How would you decide whether your boat is capable of taking another boat in tow? How would you take a lighter in tow?
40. Demonstrate your ability to handle a power boat. What are the chief differences in the handling of round-bilge and hard-chine boats? Describe the action of a "Kitchen" rudder. How do loading and trim affect the

performance of a hard-chine boat? Describe how you would turn about a single-screw boat in a narrow fairway.

41. Describe the starting and stopping routines for any power boat in your ship. Why should engine controls be left in their correct positions when the boat is made fast? What should you do if you have to leave any control, cock or valve in an unusual position? Describe the daily routine maintenance of any power boat in your ship. Why should you keep your engines clean and your bilges dry? When is an engine most likely to catch fire and why?
42. Describe the different methods of taking boats in tow.

Special Boat Operations

43. How would you beach a whaler on a gently sloping sandy beach with a crew of four men?
44. What are the dangers of surf? Describe how you would land a whaler through surf, and then take her out through the surf to your ship.
45. Describe how you would board a ship which is hove to at sea.
46. Describe how, using a whaler, you would rescue the crew of a 100-ton yacht stranded on rocks.
47. Using a whaler, what preparations would you make before recovering a practice torpedo, and how would you grapple and tow it? What precautions should be taken before taking a practice torpedo in tow?
48. What information is required before beginning to sweep for a sunken torpedo? What gear is required for sweeping with boats for a sunken torpedo? Describe how you would sweep for a sunken torpedo and recover it.
49. Describe the rig of a diver. How would you rig a diving boat? What precautions should be taken before a diver is sent down to inspect (a) a ship's underwater fitting, and (b) a ship's propeller?

Repair and Buoyancy of Boats

50. How would you make an emergency repair of a small hole in a boat? How would you make a temporary repair of the same hole?
51. What reserve of buoyancy is required for Service pulling and sailing boats? Describe how you would test a boat for buoyancy. If, after a test, a boat is found to have a negative buoyancy equivalent to $\frac{3}{4}$ cwt. what would you do? How can you find the buoyant capacity of a boat? How can you find the buoyancy of a cask?

Supply and Fitting out of Boats

52. In what condition is a boat when supplied from a dockyard to a ship, and to what scale is she then equipped? How can you check the equipment of a boat when supplied by one of H.M. dockyards? What further equipment is necessary to fit out a boat on receiving her from a Royal Dockyard? What lists and equipment should accompany a boat when she is transferred from a ship to a Royal Dockyard? Are a boat's slings part of her equipment? Who fits a boat's slings and when are they fitted?

CHAPTER VIII

LIFE-SAVING APPLIANCES AND THE ROCKET LIFE-SAVING APPARATUS

1. How are life-saving appliances classified?
2. How are the numbers and types of life-saving appliances carried in British merchant ships determined?
3. How are life-saving appliances marked, and when are they surveyed?
4. What are the general rules governing the stowage of life-saving appliances?
5. How would you tell whether a life-saving appliance has been passed fit for service?
6. How would you test a life-jacket for buoyancy?
7. How would you test a life-buoy for buoyancy?
8. Describe the lights used with life-buoys and any precautions necessary with them.
9. Describe the bell code used for life-buoys in H.M. ships.
10. What is meant by "buoyant apparatus"?
11. How would you determine the number of persons any article of buoyant apparatus is capable of supporting?
12. Describe how you would test a Carley life-float for buoyancy.
13. What equipment is provided for an inflatable life-raft?
14. Describe the routine maintenance for inflatable life-rafts.
15. How are a merchant ship's life-boats classified? What is the difference between the two types of motor boat?
16. What are "emergency boats", and what ships carry them?
17. How is the number of persons which a life-boat may carry determined?
18. What radio equipment is carried in merchant ships' life-boats, and on what frequency does it work? For how long is the equipment designed to operate in a life-boat?
19. What are the chief factors which determine the number of davits with which a merchant ship should be fitted?
20. What is the difference between a gravity davit and a quadrantal davit?
21. What are the general rules governing the stowage of a merchant ship's life-boats?
22. With what should a life-boat be equipped?
23. What is the ration provided for each person of the complement of a foreign-going ship's life-boat?
24. What is a certificated lifeboatman?
25. What is the required performance of a merchant ship's line-throwing appliance?
26. Describe briefly the rocket life-saving apparatus.
27. What signals are used when operating the rocket life-saving apparatus, and when are they given?

CHAPTER IX

ANCHORS AND CABLES AND ANCHOR WORK

Anchors and Cables, and their Equipment, Fittings and Gear

1. Name the different types of anchor supplied in the Service and state the principal differences between them.

2. How long is a shackle of cable? How many shackles of cable are there on each of the two bower anchors of your ship?
3. Describe briefly the difference between a lugged joining shackle and a lugless joining shackle.
4. How is a ship's cable attached to her bower anchor, and how is the other end secured to the ship?
5. Why is a shackle of cable made up of an odd number of links? Are all the links in a shackle of cable similar?
6. What is the principal difference between forged steel cable and wrought iron cable?
7. How are shackles of cable marked?
8. What is the purpose of "F" links, of intermediate links, and of end links?
9. Should a swivel piece be inserted in a cable with its cup facing outboard or inboard, and why? How many swivel pieces are fitted to a bower cable?
10. Demonstrate how you would part and assemble a lugged joining shackle, and a lugless joining shackle.
11. What are the principal differences between a capstan, a cableholder and a windlass? What is a warping drum?
12. When heaving in a hawser by means of a capstan, windlass, or warping drum, what is the principal danger to be avoided and how is this done?
13. Name the parts of a capstan. What is the purpose of the pawls, of the snugs, and of the whelps? Demonstrate how you would pass a swifter.
14. When working cable, does the capstan revolve with the cable holders? Can the cable holders be operated independently of each other?
15. What is the principal difference in the effect of setting the brake of a cable holder at "brake to brake" and setting it at "brake to veer", and on what occasions is each used?
16. Describe the various types of cable stopper. What is the difference between a Blake slip and a Senhouse slip? What is a compressor?
17. Describe briefly how cable is stowed.
18. How is a sheet anchor weighed?
19. What are the differences between a buoy pendant, a mooring pendant, a picking-up rope, and a catting pendant? For what purposes are each used?
20. What are the following, and for what are they used:—a bullring, clump cathead, buoy shackle, joggle shackle, adapter piece, anchor strop, cable jack, parting strop, hook-rope, chain hook, scotchman, mooring swivel?
21. How often is cable surveyed? Describe briefly the procedure for surveying cable. What markings are there on cable?
22. If a cable parts what is done with the broken pieces of the link or links?

Anchor Work

23. What is meant by shortening in cable, and when is this done? How is the direction in which a cable lies described? What is meant by the terms "short stay", "up and down", and "a'cockbill"? What are meant by surging, snubbing, and ranging, when applied to cable? Describe the degrees of a foul hawse.
24. Describe the operation of coming to a single anchor. Why is the cable braked as it runs out through the hawsepipe? Why do H.M. ships let

go their anchors with headway still on the ship? What is the advantage of anchoring on a course which is at right-angles to the wind instead of on a course which is up or down wind? Why is the weather anchor usually used?

25. What precaution should be taken when anchoring in deep water? What is the advantage of securing cable with the joining shackle just abaft the Blake slip? How is the cable secured after anchoring?
26. Describe the operation of shortening in and weighing a single anchor. Describe how anchors and cables are secured for sea.
27. How would you clear an anchor which is foul of its own cable, and an anchor which is foul of a mooring?
28. What precautions may be taken to avoid dragging when lying at single anchor in a gale? When is anchor watch set and what does it involve? How would you know if your anchor was dragging?
29. What is the difference between a running moor and a dropping moor? Describe the operation of mooring ship between two anchors. If mooring with 5 shackles on each cable, how much cable would you allow to run out on the first anchor before letting go the second anchor? How do you achieve a taut moor, and what causes a slack moor? Does the range of the tide have to be taken into account when mooring ship, and if so under what conditions? How is the mooring swivel inserted in each cable? Why is the weather anchor let go first? What is the difference between the riding and non-riding cable? What precautions may be taken to avoid dragging when moored in a gale?
30. Describe the operation of unmooring ship. Why is the lee or non-riding anchor weighed first?
31. How is a foul hawse cleared?
32. Describe the operation of securing to a buoy. What is the purpose of a bull-rope? How is the anchor catted? If securing with two bridles why are they both taken from one cable, and why are they led through the same hawsepipe? Describe the various methods of sending the picking-up rope to the buoy. What precautions should be taken in regard to the buoy jumpers when securing the picking-up rope to the buoy? If the ship is securing head and stern to buoys, how are the bridles veered to allow the ship to be secured aft?
33. Describe the operation of slipping from a buoy. Why should a slip-rope not be slipped when under stress?
34. Describe the operation of weighing by deck tackle.
35. How can a ship be pointed when riding at single anchor?

CHAPTER X

LAYING OUT HAWSERS AND ANCHORS, TOWING, AND TARGET WORK

Laying out Hawsers and Anchors

1. How would you lay out a 4-inch wire hawser to a buoy which is bearing red 45 and distant half a cable from the bows of your ship?
2. How would you take a 3-inch wire hawser from your ship across wind and tidal stream to a jetty?
3. Describe how you would lay out by boat a 5-cwt. kedge anchor in four fathoms of water where the range of the tide is 10 feet. How would you weigh the anchor?

4. Describe how you would lay out by boat a one-ton stream anchor in 3 fathoms of water where the range of the tide is 8 feet. How would you weigh the anchor?
5. Describe how you would lay out by boat a 2-ton anchor in tide-less water in a depth of one fathom. How would you weigh the anchor?

Towing

6. Describe the arrangements in your ship for taking another ship in tow.
7. Describe the arrangements in your ship for being taken in tow.
8. Describe the operation of taking a ship in tow and of slipping and recovering the tow-rope.

Target Work

9. What types of towed surface target are supplied in the Royal Navy? What rope would you use to tow a Larne target, a Hong Kong target, and a Pattern II target?
10. What are the rigs and towing arrangements of a Pattern VII target, and of a Pattern II target?
11. What are the maximum speeds of tow of a Hong Kong target, a Pattern II target, and a high-speed battle-practice target?
12. What are the lengths of tow for sub-calibre practices, full-calibre practices, and night firings, of all descriptions?
13. Describe the towing arrangements of a high-speed battle-practice target.
14. How is a battle-practice target secured for towing alongside?

CHAPTER XI

PARAVANES AND MINESWEEPING

Paravanes

1. Does a paravane afford protection to a ship against all types of mine? If not, against which type is it effective?
2. Describe briefly how a paravane operates.
3. When is a floating mine usually safe?
4. Can a paravane be run on either side of a ship?
5. Can a paravane be towed at any speed without adjustment?
6. How can you find out whether a paravane is suitably adjusted for towing at a certain speed?
7. Describe the gear required for towing paravanes.
8. Describe the arrangement of the gear provided in your ship for towing, and for recovering, paravanes.
9. Describe how paravanes are streamed, and recovered, in your ship.
10. Describe how you would dislodge a paravane which has lodged under the bilge keel of a ship.
11. What would you do if you saw a mine foul of one of your paravanes?
12. If it is necessary to jettison the paravanes when they are streamed, how is this done?
13. The paravane chain of your ship parts as you are preparing to stream paravanes; how would you reeve the spare chain?

Minesweeping

14. Describe briefly the two chief types of mine.
15. Describe briefly the " A " sweep method of minesweeping.
16. Describe how the " A " sweep is passed, (a) between two ships, and (b) between three or more ships.
17. Describe how the " A " sweep is slipped and recovered.
18. Describe briefly the " Oropesa " sweep method of minesweeping.
19. Describe how an " Oropesa " sweep is (a) streamed, and (b) recovered.
20. Compare the advantages and disadvantages of the " A " and " Oropesa " sweeps with each other ?
21. Describe briefly the " two-speed " sweep.
22. Describe how you would lay and recover a Dan buoy.

CHAPTER XII

REPLENISHMENT AT SEA

1. Name the different methods of transfer used in replenishment at sea.
2. What is the purpose of the distance line and how is it used ?
3. How are the various transfer positions marked ?
4. Describe, with the aid of a sketch, a " light jackstay rig " for the transfer of loads of up to 5 cwt.
5. Describe how contact between two ships is established, how a light jackstay rig is passed from one ship to the other, and how it is rigged, worked, and recovered.
6. Describe with the aid of a sketch, the " jackstay fuelling rig ". What is the chief advantage of this rig as compared with the derrick fuelling rig ?
7. Describe, with the aid of a sketch, the crane rig for fuelling abeam from one warship to another. Describe how this rig is passed, rigged, worked, and recovered.
8. Describe, with the aid of a sketch, the rig for fuelling astern from a tanker. Describe how connection is established between the tanker and the ship astern of her, and how the hoses are cast off.
9. Describe, with the aid of a sketch, the rig for fuelling astern from a warship.

CHAPTER XIII

AIRCRAFT

1. How are aircraft classified ?
2. Name the control surfaces of an aeroplane, and the functions of each.
3. On what parts of an aeroplane can you pull, push, or lift, without fear of causing damage ?
4. How is a landplane secured in a carrier's hangar ?
5. How is a landplane slung when being hoisted in or out of a ship ?
6. What extra gear should a boat carry which is attending on seaplanes ?
7. Sketch roughly the lay-out of an extempore flare-path for seaplanes.
8. If a seaplane is to land at night beside your ship, what arrangements would you make ?
9. How is a seaplane towed ?
10. How are baggage, passengers and stores transferred from a boat to a seaplane under way ?

11. How should a boat approach a seaplane moored to a buoy? How would you make fast to a buoy at which a seaplane is moored?
12. What important points should be borne in mind when going in a boat to the rescue of a crashed aircraft?

CHAPTER XIV

DAMAGE CONTROL, AND SHIP STABILITY

Damage Control

1. Describe generally the damage control organisation of your ship.
2. How are the three damage control telephone systems distinguished from each other?
3. What are the functions of the A.B.C.D. H.Q., H.Q.2, E.P.1, E.P.2, and D.C. bases?
4. What parties would you expect to find in a D.C. section when your ship is at the first state of readiness?
5. What are the duties of a W.T. integrity patrol?
6. Who controls the opening and closing of water-tight openings in your ship?
7. What are the states of readiness, and when are they assumed?
8. Why do the states of readiness of a ship not agree with her degrees of readiness?
9. What is meant by the "water-tight condition" of a ship? Explain the different water-tight conditions.
10. Under what circumstances is the order "close red and blue openings" given?
11. What is the order for changing from Condition XY to Condition Z? What is the order for changing from Condition X to Condition XY?
12. What is the "Water-tight Door and Hatch Board", and what is its purpose?
- 12a. Describe the system of identification markings for main and sub-compartments, and for doors, hatches, ventilation valves and seacocks.
13. What is the *Water-tight Integrity Log*, and what is its purpose?
14. What principles govern the stowage of damage control equipment?
15. What equipment is provided for leak stopping?
16. Describe how you would stop a leak through a splinter hole 3 inches in diameter, (a) if it were clean cut, and (b) if it had jagged edges.
17. How would you stop flooding through a hole 2-ft. square?
18. What is the relation between the distance below the waterline of a hole in the ship's side and the rate of flow of water through it?
19. What are the pumping capacities of the electric and diesel portable pumps in your ship?
20. How many men would you detail to transport (a) an electric portable pump, and (b) a diesel portable pump?
21. What principles govern the inspection routines of damage control equipment?
22. In your ship, when is the following equipment inspected and tested:—life-jackets; life-floats; anti-flash gear; gas masks; water-tight fittings; secondary lighting; portable pumps; torches; hand extinguishers;

foam units; hoses; battery lamps; ventilation systems; scupper and drain valves?

23. How can a fitting such as a water-tight door or a scuttle be tested for water-tightness?
24. How can a compartment be tested for water-tightness?
25. How are the following pipe systems marked :—firemain; salt water sanitary; oil fuel; petrol?
26. With the aid of sketches, demonstrate how you would shore a bulkhead, a deck, a hatch and a door.
27. What are the principles of shoring? What is a pad-piece? How are wedges driven in? If wedges and shores are covered with oil fuel what would you do to prevent them from slipping? How would you shore a leaking water-tight door? Why should not a compartment be shored in anticipation of damage? Why should not shores be cut to fit their positions in anticipation of damage?

Ship Stability

28. Explain the relation between a ship and the weight and volume of the water she displaces.
29. Does the shape of a ship's hull have any bearing on her draught?
30. What do the following terms mean :—buoyancy, reserve of buoyancy, and freeboard?
31. What do the following terms mean :—list, heel, and trim?
32. What precautions should be taken in the loading and handling of a boat in regard to her stability?
33. What are the meanings of the terms centre of gravity, and centre of buoyancy?
34. If two weights were suspended, one near each end of a pivoted horizontal bar which was out of equilibrium, how could you restore the bar to a state of equilibrium?
35. Draw a sketch of the section of a ship showing the righting effect of the forces of buoyancy and gravity.
36. Explain, with the aid of sketches, the effect of the centres of gravity and buoyancy on the stability of a ship.
37. Why is it undesirable for a ship to be either too lively or too sluggish in a seaway?
38. What is the effect of off-centre loading on a ship?
39. What effect has list on the stability of a ship?
40. Show the effects on a ship's stability of adding (a) ballast and (b) top-weight.
41. What is the danger of free-surface water to the stability of a ship?
42. What precautions are taken to guard against the ill-effects of free-surface water?
43. How is list corrected?
44. Describe loll and show how the stability of a ship is affected by it.
45. What is the difference between list and loll?
46. How is loll corrected?
47. What are the effects of list and trim on the fighting efficiency of a ship?

CHAPTER XV

SHIP MAINTENANCE

Paint and Painting

1. What is a primer and where is it used? Give as many examples of primers as you can remember.
2. What is flatting and where is it used?
3. What properties should a finishing coat have? What paints are used for finishing coats in the Royal Navy?
4. What are the following : pigment, vehicle, driers, and thinners?
5. What type of paint would you use to paint a deckhead, lagging, and the double bottoms?
6. What are the two compositions used for painting a ship's bottom? What are the special properties of each?
7. Describe how you would mix a tin of paint, and a drum of paint, preparatory to painting.
8. About how much paint would be required to paint the sides of your ship?
9. Describe how you would prepare the side of your ship for repainting.
10. Describe how a wood surface should be prepared for re-painting.
11. For what purposes are the following brushes used : flat brush, sash tool, and fitch? How should brushes be cleaned and maintained?
12. Describe how paint should be applied with a brush.
13. Describe the working of a spray-gun.
14. Describe how paint should be applied with a spray-gun.
15. Describe how you would clean a spray-gun after use.
16. What precautions should be taken when using a spray-gun?

General Ship Maintenance

17. As Captain of a Top how would you deal with defects in your part-of-ship?
18. As Captain of a Top what special details would you observe in regard to the fitting, maintenance, and inspection of the following items : standing and running rigging ; hawsers ; slings ; parcelling, service and seizings ; blocks and tackles ; life-rafts ; fire appliances ; water-tight fittings?
19. How would you clean the following : wood decks ; brightwork ; canvas ; corticene ; lagging ; leather ; rubber ; bare woodwork ; varnished woodwork.

CHAPTER XVI

NAVAL COMMUNICATIONS

Flag Signalling

1. What do the following terms signify : a hoist, at the dip, display, tackline, superior, and inferior?
2. What are "superior" and "inferior" positions on a signal mast?
3. How is a signal made, answered, and executed?
4. What is a callsign? What is the callsign of your ship? What is the callsign of your second motor-boat?
5. What flags are used on the forecastle to indicate the state of the anchors and cables when working cable? What do the following flags signify

when used on the forecastle : Uncle, Able, Negat, Charlie, and Numeral flags ?

6. When anchoring what are the significations of *Uncle* when broken at the dip, and when hauled down ? When mooring what are the significations of *Uncle* when used in the following sequence : close up, hauled down, and at the dip ?
7. Where is a Boat's Signal Book kept and how is it protected from wear and tear ?
8. How long and how wide is a bolt of bunting ? What is the width of a breadth ?
9. In what length and sizes is signal halyard supplied ? How does signal halyard differ from ordinary cordage ?
10. In what sizes are signal flags supplied ? Which is the largest size and which the smallest ?
11. How are signals halyards belayed ? How are signal flags stowed ?
12. Demonstrate how you would make up a flag for breaking close up ?
13. How would you lace an ensign for hoisting on a staff ? What is a head-stick and how is it fitted ?

Signalling Procedure

14. What are "abbreviations", "prowords" and "prosigns" ? Give the prowords for the following prosigns : AA, DE, G, BT, WB, IX. Give the prosigns for the following prowords : disregard this transmission, do not answer, I say again, unknown station, correction, Roger, over, and out.
15. You are away in your ship's second motor boat and your engine breaks down ; you anchor in a safe berth and your engine-room rating reports that two sparking plugs are required to put the engine in order again ; draft out the signal you would make to your ship on your Aldis light, and write down how it would be recorded if you had used the correct procedure. Describe the procedure for sending the same signal by semaphore.
16. What are the six "precedence indicators" and for what types of message is each used ?
17. What are the five "security classifications" and for what types of message is each used ?
18. You are away from your ship in a boat on detached duty of a confidential nature ; you are in wireless communication with your ship, and you want her to send your mails, together with a week's supply of fuel and provisions, to a prearranged position called X to await your arrival there in two days time ; write down the signal you would make.

CHAPTER XVII

CEREMONIAL

1. What constitutes a "suit of colours" of one of H.M. ships in commission ?
2. When and by whom is the Union Flag worn afloat ?
3. When is a jack worn by H.M. ships ?
4. When do H.M. ships wear a masthead pennant ?

5. Between what routine times are colours worn by H.M. ships in harbour? Are they ever worn at other times? When is the masthead pennant hauled down? When is the jack hauled down or rehoisted?
6. When is the ensign worn at sea?
7. When are ensigns half-masted?
8. When are ensigns worn by boats?
9. Are guards and bands (when available) paraded every day for "Colours"?
10. When do Flag Officers wear their flags? Is the masthead pennant worn by a ship at the same time as a Flag Officer's flag? In a two-masted ship, where are Flag Officers' flags worn?
11. Who wears the Senior Officer's pennant, and where is it flown?
12. What is the signification of the following flags or discs when displayed in boats :—
 - (a) a white St. George's Cross with two red balls?
 - (b) a masthead pennant?
 - (c) a red disc?
 - (d) a white disc?
 - (e) a blue disc?
13. It is a dark night and you are sent to the flagship of the Vice-Admiral commanding the 3rd Cruiser Squadron; how could you distinguish her from other ships in harbour?
14. On what occasions are ships dressed overall? Describe how ships are thus dressed.
15. What is meant by the expression "military honours"? Between what times are they accorded?
16. What military honours, if any, are accorded to the following persons :—
 - (a) the Rear-Admiral commanding the 4th Cruiser Squadron?
 - (b) an Engineer Rear-Admiral?
 - (c) the Chief-of-Staff to the Commander-in-Chief, Mediterranean Fleet?
 - (d) the General Officer Commanding, Southern Command?
17. Between what times is the side piped?
18. To which, if any, of the following persons is the side piped :—
 - (a) the Governor General of Ceylon?
 - (b) the Commodore of the Royal Yacht Squadron?
 - (c) the Master of Trinity House?
 - (d) the Lord Mayor of London?
 - (e) the Flag Captain?
 - (f) a member of the board of a court martial?
 - (g) an Engineer Lieutenant of a foreign warship?
 - (h) the Chief-of-Staff to the Commander-in-Chief, if a Commodore?
 - (i) the Admiral Superintendent of H.M. Dockyard, Chatham?
 - (j) an Admiral of the Fleet when in plain clothes?
19. Is a Surgeon Lieutenant entitled to a pipe? If so, when?
20. What do the following replies signify to the hail of "Boat Ahoy" :—
 - (a) "Flag, Newfoundland"?
 - (b) "Staff, Duke of York"?
 - (c) "Newfoundland"?
 - (d) "No, no"?
21. What do the following indicator plates denote when displayed in a boat :—
 - (a) Admiralty flag plate?

- (b) red disc ?
- (c) blue disc ?
- (d) white disc ?
- 22. What salutes are accorded to a boat passing a ship at anchor if the boat is wearing or displaying :—
 - (a) an Admiralty flag plate ?
 - (b) a broad pennant ?
 - (c) a red disc ?
 - (d) a blue disc ?
 - (e) a white disc ?
- 23. What marks of respect are paid in a power boat, a boat under oars, and a boat under sail, when passing a boat wearing or displaying :—
 - (a) the flag of an ambassador ?
 - (b) a red disc ?
 - (c) a blue disc ?
 - (d) a white disc ?
 - (e) a command pennant ?
- 24. As coxswain of a power boat alongside a landing place what marks of respect would you pay to :—
 - (a) a Brigadier ?
 - (b) a Group Captain ?
 - (c) a Commodore ?
 - (d) a Captain in command of a ship ?
 - (e) a Surgeon Commander ?
- 25. What salutes, if any, are paid by boat-keepers to senior officers passing in boats ?
- 26. How would you call a boat's crew to attention ? Describe the position of attention when seated in a boat.
- 27. When is the bugle used for salutes between ships, and when is the boat-swain's call or whistle used ?
- 28. When two ships are under way in harbour what salutes, if any, are exchanged between them ?
- 29. When are the ensigns of H.M. ships dipped ?
- 30. Give four instances of occasions for gun-salutes.
- 31. Are any flags, other than the ship's colours, flown during a gun-salute ?
- 32. Are salutes logged ?

CHAPTER XVIII

RULE OF THE ROAD

1. What are the "Steering and Sailing Rules", and upon what principles are they framed ?
2. What is meant by the term "risk of collision" and how is it determined ?
3. What is meant by the terms "steady", "drawing forward", and "drawing aft", when used in relation to the compass bearing of another vessel ?
4. When two vessels approach one another on a steady relative bearing, which vessel should give way ?
5. By means of a sketch show the arcs of the horizon relative to a vessel which determine whether she should hold her course or give way to an approaching vessel.

6. Define the following terms :—" steam vessel ", " sailing vessel ", " under way ", " on the starboard tack ", " on the port tack ", and " running free ".
7. How would you describe the term " low visibility "? Can sandstorms and hailstorms be considered under the same category?
8. What immediate action should a vessel take when she encounters conditions of low visibility?
9. What action should a vessel take when she hears before her beam the sound signal of another vessel?
10. Two sailing vessels are approaching one another on a steady relative bearing; which of the vessels gives way under the following circumstances :—
 - (i) both close-hauled on opposite tacks?
 - (ii) one running free and the other close-hauled?
 - (iii) both running free?
 - (iv) both running free, one with the wind right aft?
 - (v) both close-hauled on the same tack?
11. Does an auxiliary vessel sailing close-hauled give way to a sailing vessel running free?
12. When does a steam vessel give way to a sailing vessel?
13. Two steam vessels are approaching one another on a steady relative bearing; which of the vessels gives way under the following circumstances :—
 - (i) when each is approaching the other end on or nearly end on?
 - (ii) when not end on, but each is before two points before the other's beam?
 - (iii) when one is two points abaft the other's beam?
 - (iv) when one is abaft two points of the other's beam?
14. What is the rule concerning vessels navigating a narrow channel? How does a sailing vessel obey this rule?
15. When may the Steering and Sailing Rules be disregarded?
16. What are the sound signals prescribed for vessels taking avoiding action? Do sailing vessels sound these signals? When should these signals be sounded? What precaution would you take with a steam whistle to ensure making the correct signal?
17. Risk of collision exists between your vessel and another, but your vessel has right of way; what should you not do under these circumstances?
18. You sight an approaching vessel on your port bow, and shortly after you have to alter course to avoid a shoal patch; what would you do?
19. If yours is the vessel which has to take avoiding action, what points would you bear in mind when deciding what action to take and when to take it?
20. Should a steam vessel give way to a steam fishing vessel?
21. Do you know of any important rule concerning ingoing and outgoing traffic in a harbour?
22. Does a floating bridge have any right of way in a harbour?
23. With the aid of a sketch describe the navigation lights carried by a steam vessel over 150 feet in length.
24. What navigation lights should you expect to be carried by—
 - (a) a steam vessel 100 feet long?
 - (b) a steam vessel of 21 tons gross?

- (c) a warship's picket boat ?
- (d) a sailing vessel of 39 tons gross ?
- (e) a sailing vessel of 10 tons gross under way but not making way ?
- (f) a dinghy under sail ?
- 25. When should navigation lights be switched on and off ?
- 26. What are—
 - (a) secondary navigation lights ?
 - (b) a fog light ?
 - (c) a shaded stern light ?
- 27. How can a steam vessel's course be judged by the appearance of her steaming lights ?
- 28. On what approximate course would you judge a vessel to be if you sighted—
 - (a) her starboard side-light to starboard ?
 - (b) her port side-light to port ?
 - (c) her port side-light before 2 points before your starboard beam ?
 - (d) her starboard side-light before 2 points before your port beam ?
 - (e) either of her side-lights abaft 2 points before either beam ?
 - (f) her stern light before 2 points before either beam ?
 - (g) her stern light abaft 2 points before either beam ?
- 29. How can you distinguish whether a warship and a merchant ship are at anchor, by day and by night ?
- 30. What lights may a flagship carry when at sea, and when at anchor ?
- 31. Does a vessel towing another have right of way ?
- 32. What are the principal differences between a trawler, a drift-net vessel, and a seine-net vessel, in their methods of fishing ?
- 33. How does a vessel indicate that she wishes other vessels to pass her at slow speed ?
- 34. How does a vessel indicate that divers are down alongside her ?
- 35. Does an aircraft taxiing on the water have right of way ?
- 36. What sound signals should be made in low visibility by—
 - (a) a steam vessel having way on her ?
 - (b) a steam vessel under way but stopped and having no way on ?
 - (c) a sailing vessel running free ?
 - (d) a sailing vessel at anchor ?
- 37. What would the following sound signals indicate :—
 - (a) a long blast followed by two short blasts ?
 - (b) a long blast followed by three short blasts ?
 - (c) one long blast followed by a bell rung rapidly ?
- 38. What lights are displayed at night, what signals are displayed by day, and what sound signals are made in low visibility, by each of the following vessels :—
 a vessel towing, a vessel towed, a vessel not under command, a vessel aground near a fairway, a dredger, a fishing vessel, a trawler, a drift-net vessel, a seine-net vessel, a lightship out of her proper position, a pilot vessel, a cable-laying ship, a vessel sweeping, an Examination Service vessel, an aircraft under way, an aircraft at anchor, and a floating bridge ?
- 39. How does a fishing vessel indicate that she has an urgent communication to make to one of H.M. ships ?
- 40. What signals are flown by vessels running taut-wire gear, and by vessels running speed trials ?

41. How does a ship in British waters indicate that she requires a pilot ?
42. What do the following sound signals of the Morse code indicate : R, U, V, K, O, H. ?
43. What distress signals may be made by a vessel by day, and by night ?

CHAPTER XIX

CONNING AND STEERING

1. Describe the purpose of the following instruments :—rudder indicator, wheel indicator, steering order transmitter, gyro-tape-repeater, telegraph order repeater, shaft movement indicator, and revolution repeater.
2. Describe the gyro-alarm system.
3. What precautions are taken in regard to the steering and engine order mechanisms before a ship proceeds to sea ?
4. What precautions are necessary when operating a steam siren ?
5. Who comprise the special sea duty men ?
6. What alternative primary conning and steering positions are provided in warships ?
7. Describe the sequence of operations necessary to change over from the primary steering position to the secondary steering position, and back to the primary position.
8. In a telemotor system, what is the purpose of the pressure gauges on the wheel pedestal ?
9. Give a general description of the telemotor steering system.
10. What precautions are necessary when operating the telemotor steering system ?

CHAPTER XX

SHIPS' COMPASSES AND DIRECTION BY COMPASS

Gyro-compasses

1. Whereabouts in a ship would you expect to find her gyro-compasses ?
2. After a gyro-compass is started, what interval of time must elapse before it will record a correct direction ?
3. What is a gyro-repeater ? How is it lined up ?
4. For what reasons may a repeater indicate an incorrect direction ?
5. What should you do before first using a gyro-repeater ?
6. How would you ensure that a gyro-repeater is working correctly ?
7. How is the " failure " of a gyro-compass indicated ?
8. What is gyro error ? How is it recorded, and how is it applied to obtain a true direction ?
9. What are the differences between a bearing repeater, and a steering repeater of the tape type ?
10. What is a " Pelorus " ? What is the purpose of a wing repeater ?

Magnetism and Magnetic Compasses

11. What is the difference between magnetic and non-magnetic substances ?
12. If two magnets are placed side by side, which ends tend to attract each other and which tend to repel each other ?

13. What is a magnetic field? What are lines of magnetic force?
14. How can the properties of magnetism be introduced into a magnetic substance?
15. How does the Earth's magnetism affect a pivoted magnetic needle?
16. Do the Earth's lines of magnetic force run directly between the Magnetic North and South Poles?
17. What is variation? Is variation the same at all places on the Earth? Does it alter from year to year at any one place? Where is the variation at any place recorded?
18. What is the difference between a magnetic and a true direction?
19. What is the rule of thumb method for applying variation to a magnetic direction in order to obtain a true direction, and vice versa?
20. The bearing of a lighthouse is 115° magnetic; if the variation at that place is 17°E. , what is the true bearing of the lighthouse?
21. How does a ship acquire magnetic properties?
22. What is deviation? Is it the same for all the magnetic compasses in a particular ship? Is the deviation of a particular compass the same for all directions of the ship's head?
23. Does electricity affect a magnetic compass?
24. Describe briefly how a ship's compasses are adjusted for deviation. When are ship's compasses adjusted for deviation?
25. What is the rule of thumb method for applying deviation when converting a compass direction to a magnetic direction, and *vice versa*?
26. What is the compass course to steer if the magnetic course is 323° and the deviation for that direction is 3°W ?
27. How are true, magnetic, and compass directions recorded?
28. The bearing of a lighthouse from a ship steering 123°C is 358°C ; what is the true bearing of the lighthouse if the variation is 3°W and the deviation for course 123°C is 4°E ?
29. What is the total error of a magnetic compass? What is a compass comparison disc?

Compass Equipment

30. What is a bearing plate, and how is it used?
31. Demonstrate your ability to take a bearing.
32. What is the relation, if any, between an azimuth circle and a compass?
33. How is a compass illuminated?
34. In a Royal Dockyard, to whom would you apply for advice and information on gyro-compasses and on magnetic compasses?

CHAPTER XXI

MEASUREMENT OF SPEED AND DISTANCE

1. State the number of :—
fathoms in a cable ;
cables in a sea mile ;
feet in a sea mile.
2. What is a knot?
3. Describe the Dutchman's log and the hand log.
4. What is a "revolution table"?

5. Name the different parts of a towed log of the Trident type.
6. What is the general relation between the length of the log-line and the speed of the ship when using a Trident log?
7. What is the purpose of the governor, and of the "fish"?
8. What care is necessary with the log-line?
9. Describe the operations of streaming and handing the Trident log.
10. What are the disadvantages of a towed log?
11. Give a general description of the Chernikeef log.
12. What is the purpose of the lamp box?
13. Can you ascertain the speed of the ship from the lamp box?
14. How can the recording of a Chernikeef log be altered?
15. Describe the routine for lowering and starting a Chernikeef log.
16. When should a Chernikeef and a Pitometer log be housed?
17. Give a general description of the Pitometer log, type M.A. 3.
18. Give a general description of the Pitometer log, type D.
19. What is the purpose of the cam-control transmitter?
20. Describe the starting routine for a Pitometer log.
21. What is the purpose of a Stuart's distance meter?
22. By practical demonstration show that you know:—
 - (a) how to take a range with a Stuart's distance meter when the waterline is visible;
 - (b) how to take range with a Stuart's distance meter when the waterline cannot be seen.

CHAPTER XXII

SOUNDING

Sounding by Machine

1. What are the principles employed when sounding with the Kelvin sounding machine?
2. What corrections have to be applied to the results obtained by each method?
3. What equipment is required to sound by this machine?
4. How long is the sounding wire? How is it secured to the drum of the machine? What precautions are necessary in regard to the care and maintenance of the wire?
5. What is the length of the stray-line, and where, along its length, should the guard-case be secured?
6. What types of sounding tube are supplied? How are they supplied and what precautions are necessary in regard to their storage and use?
7. What care and maintenance are required in regard to the traveller and high speed sheave?
8. Describe the operation and purpose of the following parts of the sounding machine: hand brake, automatic brake, ball-and-ratchet device, and hand crank.
9. If the electric winding motor breaks down, what alterations are necessary to operate the machine by hand?
10. Before operating a sounding machine what detail requires attention?
11. Describe the operation of taking a sounding by machine?

12. If less than 300 fathoms of sounding wire is used, what adjustment and correction is required to obtain the correct sounding?
13. Where are soundings logged?
14. What are the probably causes of incorrect soundings by tube?

Echo Sounding

15. What is the principle on which echo sounding is based?
16. Describe the general lay-out of the equipment provided for echo sounding.
17. For what purpose is the speed of the recording paper altered?
18. To how many speeds can the stylus be adjusted, and what range of soundings is covered by each speed?
19. What is the effect of "phasing"?
20. What is the purpose of the red and black scales, and what correction has to be made to their readings when phasing?
21. What is the purpose of the "flashing unit"?
22. Describe the series of operations required to take an echo sounding.

CHAPTER XXIII

LATITUDE AND LONGITUDE, CHARTS AND HYDROGRAPHIC PUBLICATIONS

Latitude and Longitude

1. What relation, if any, is there between a sea mile and (a) a degree of latitude, (b) a degree of longitude?
2. What is a great circle?
3. What is a rhumb line?
4. Does the shortest distance between any two places on the Earth lie on the track of a great circle or that of a rhumb line?

Mapping

5. Describe the chief distortion of the Earth's surface when it is represented by a Mercator's projection.
6. How is distance measured on a Mercator's chart?
7. What are the chief uses of a gnomonic or great-circle chart?
8. How do a great circle and a rhumb line appear on a Mercator's chart?

Charts

9. What is the difference between a large and a small scale chart?
10. How can you tell whether any particular chart is the latest one available?
11. Describe how you would make and record a small correction on a chart.
12. How are corrections by "Temporary" and "Preliminary" "Notices to Mariners" made on charts?
13. When drawing new charts from a chart depot, to what extent would you expect them to be corrected and what further corrections, if any, are necessary?
14. How are charts arranged, and how would you know where to look for any particular chart?
15. Where would you find full information on the supply and correction of charts and other hydrographic publications?

Hydrographic Publications

16. In what editions are Notices to Mariners published?
17. What information would you expect to find in Notices to Mariners?
18. Describe how you would correct a chart by means of a "block correction".
19. If you were referred to the "North Sea Pilot", what would you look for and what information would you expect to find?
20. What information would you expect to find in the following publications : *Admiralty List of Lights* ; *Admiralty List of Radio Signals* ; *Nautical Almanac* ; *Nautical Tables* ; *Admiralty Tide Tables* ?
21. Where would you find details of light-buoys?

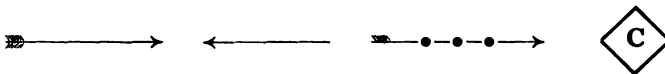
CHAPTER XXIV**TIDES AND TIDAL STREAMS****Tides**

1. What is a spring tide and what is a neap tide?
2. Roughly, at what intervals would you expect spring and neap tides to occur around the coasts of the British Isles?
3. Suppose the Moon were full the day before yesterday, what kind of tides would you expect to-day?
4. What is the approximate interval between springs and neaps?
5. Suppose the Moon were midway between new and half moon last night, what would you expect the state of the tides to be to-morrow?
6. What is the difference between a diurnal tide and a semi-diurnal tide?
7. Do spring and neap tides always follow closely on the phases of the Moon throughout the world?
8. Are the rise and fall of the tides similar throughout the world?
9. What effect has the weather on local tides?
10. Suppose high water this afternoon occurred at 1750, when would you expect the next low water to occur?
11. If low water occurs at 0920 this forenoon, when would you expect low water to occur to-morrow forenoon?
12. If the tide has a 12-hour period, what would be the approximate interval between two successive high waters?
13. What is the stand of a tide? Does the stand of the tide in a large harbour occur at the same time at all places in the harbour?
14. What is the range of a tide?
15. Does a 6-hourly tide rise and fall at a uniform rate throughout its range?
16. Give the rough rule for estimating the hourly rate of rise or fall of a 6-hour tide.
17. At what period does a tide rise or fall fastest?
18. At what state of the tide is it wisest to approach an unknown harbour?
19. If a harbour launch ran hard aground two hours after high water, when could the coxswain expect to refloat her without assistance?
20. If this launch ran hard aground at high water three days before springs, how long would it be before one could expect to refloat her without assistance.
21. What is meant by the following terms :—
mean level ; tide ; high water ; low water ; M.H.W.S. ; M.H.W.N. ; M.L.W.S. ; M.L.W.N. ; chart datum ?

22. What is the rise of the tide ?
23. What will be the approximate heights of high and low water at a certain place on the south-west coast of England two days after full moon ? Tide tables are not available, but you have a chart of the locality which shows M.H.W.S. to be 18·6, M.H.W.N. to be 16·9, M.L.W.S. to be 1·6 and M.L.W.N. to be 3·3.
24. If the time of high water in the previous question was 0715, what would be the approximate height of the tide at 1115 ?
25. In how many volumes are the *Admiralty Tide Tables* published ? What is the difference between Parts I and II of each volume ? What is the difference between a " standard " and a " secondary " port ?
26. To what times do the tidal predictions refer in the three volumes ?
27. With the aid of the Tide Tables, find the standard times of high and low water p.m. on June 3rd at Hook of Holland, assuming that the standard time of Holland is — 00 20.
28. Find the standard times of high and low water p.m. June 3rd at Rotterdam.

Tidal Streams

29. What is a tidal stream ? Does its flow coincide with the rise and fall of the tide ? How is the direction of a tidal stream described ?
30. If you had to pull up-stream to a ship anchored in mid-stream, how would you shape your course ?
31. Does the fairway of a river or channel always lie midway between its banks ?
32. In a harbour situated at the mouth of a river, when would you expect the streams to run at their strongest rate ? Would the ingoing and outgoing streams be of the same strength and duration ?
33. What is a weather-going tide ?
34. Which are the left and right banks of a river ?
35. What are eddies, ripples, overfalls, and races ? Is any particular care required in their vicinity ?
36. Where is information on tidal streams to be found ?
37. What does each of the following symbols on a chart indicate ?



38. How can the direction and rate of a tidal stream be forecast from information on a chart ?
39. What is slack water ?

CHAPTER XXV

INTRODUCTION TO PILOTAGE

1. How would you plot the following position ?
172 Nab Tower 13.
2. What precaution is necessary before comparing magnetic with true directions on the compass rose of a chart ?
3. What is meant by the term " total compass error " when applied to a magnetic compass ?

4. If the bearing of a lighthouse is 146° by magnetic compass, what is the true bearing of the lighthouse if the total compass error is 7° W?
5. If the true course is 294° , what is the magnetic compass course if the total compass error is 15° E?
6. How can a navigator see at a glance from the chart by what means recorded positions have been obtained?
7. *Chart 5110*.—(All courses and bearings are magnetic; tidal streams are true.)

On 8th March, 1951, a destroyer was steaming at 25 knots, course 073° , deviation 2° E.

At 2000 Table Cape Lt. bore 139° ;

at 2052 Table Cape Lt. bore 216° .

Write down the fix at 2052.

At 2100, course was set for a point 5 miles north of Swan Island Lt., the estimated tidal stream being 210° at 3 knots.

Find the compass course if the deviation on this new course is $2\frac{1}{2}^\circ$ E; and find the estimated position at midnight.

At 0020, 9th March, Swan Island Lt. bore 114° distant 12 miles.

Fix the ship at 0020.

8. *Chart 5109*.—(All courses and bearings are magnetic; tidal streams are true.)

On 15th February, 1951, a destroyer was steaming 188° at 22 knots.

At 0905 Green Pt. Lt. bore 084° ;

at 0918 Slang Kop Lt. bore 150° .

Fix the ship at 0918.

At 1010 course was altered to 136° , when Cape Pt. Lt. bore 084° , distant about 9.5 miles. Current is estimated to be 3 knots setting 164° .

At 1030 Cape Pt. Lt. bore 032° .

Fix the ship at 1030.

9. *Chart 5115*.—(All courses and bearings are magnetic.)

On a certain day in November, 1950, at 0900, a ship was steaming out of the Cromarty Firth at 12 knots, course 046° . Deviation was $3\frac{1}{2}^\circ$ E. Tidal stream setting throughout, 78° (true) at 4 knots.

At 0900 Tarbat Ness Lt. bore 323° ;

at 0920 Tarbat Ness Lt. bore 275° .

Fix the ship at 0920 and find the D.R. and E.P. at 1100.

At 1100 Course was altered to pass 5 miles from Noss Head Lt.

Assuming that the deviation on this new course is 5° E, *find the compass course and speed made good.*

At 1150 Clyth Ness Lt. bore 267° ;

at 1210 Noss Head Lt. bore 328° .

Fix the ship at 1210.

10. *Chart 5109*.—(Courses and bearings are true.)

At 1400 a ship was steering 142° , at a speed of 16 knots, Cape Pt. Lt.

bore 189° and beacons were in transit bearing 296° as shown on the chart. At 1430 Cape Pt. Lt. bore 276° , distant 5 miles.

Estimate the strength and set of the tidal stream. Find the course required to pass through a point 180 Pt. Danger Lt. 5.

11. *Chart 5110.*—Ship's course 073° , speed 12 knots.

At 1000 Needle Rock Lt. was abeam, distant 11 miles ;
at 1200 Eddystone bore 199° , distant 5 miles.

Find the average set of the tidal stream.

At 1300 course is set for a point 135 Tasman Head 8.

Assuming the tidal stream remains unchanged, find the course to be steered and the time of arrival at this point.

12. How can the deviation of a magnetic compass be checked ?
13. When fixing a ship's position by compass bearings of shore objects, what should be borne in mind when selecting the objects ?
14. What should be borne in mind when fixing a ship by bearing and sounding ?
15. How is the approximate position of a ship estimated by bearing and horizon range ?
16. In a fog and near cliffs a vessel sounds a blast on her siren. If the time between the sound and the echo is 8 seconds, what is her approximate distance from the cliffs ?
17. Why should a buoy not be used for fixing the position of a ship if shore objects are visible ?
18. If you were in charge of a vessel what would you do on entering fog ?

CHAPTER XXVI

THE SOLAR SYSTEM, TIME AND THE STARS

The Earth and the Sun

1. What are the equinoxes and the solstices, and when do they occur ? On what does the length of a day depend ?
2. Define sunset and sunrise.
3. What is twilight, and what are its three categories ? On what does the duration of twilight depend ?
4. Does the Sun always rise due east and always set due west ? On what does the bearing of the Sun at sunrise and sunset depend ?

Time

5. What is the difference between apparent and mean time ?
6. What is the relation between longitude and time ? If you are voyaging eastward would you advance or retard your watch with the change of longitude ? Is the time at the Falkland Islands slow or fast on the time in Great Britain ?
7. What change of longitude corresponds to a difference in time of 7 hours, 17 minutes, 27 seconds ? What difference in time corresponds to a change of longitude of $8^\circ 18' 28''$?
8. What is the difference between Greenwich mean time and local mean time ?

9. What is the date line and where is it? If you cross the date line from west to east, how would you alter the date?
10. What are the G.D. and G.M.T. when the L.D. and L.M.T. are March 2, 1500 at a position in longitude $165^{\circ} 20' W$? What are the L.D. and L.M.T. at a position in longitude $170^{\circ} 20' E$, when the G.D. and G.M.T. are September 20, 0500?
11. What is zone time, and how is the Earth divided into zones? What are the central meridian and the boundary meridians of zone — 7? What is the maximum difference between zone time and local mean time?
12. What are the G.D. and G.M.T. when the Z.D. and Z.T. are January 16, 07. 17. 27. at a position in Zone — 6? If the G.D. and G.M.T. are October 26, 18. 28. 08. what are the Z.D. and Z.T. at a position in zone — 6? What is the Z.T. at a position in longitude $38^{\circ} 54' E$. when the L.M.T. is 15. 07. 24? What is the L.M.T. at a position in longitude $123^{\circ} 20' W$ when the Z.T. is 08. 22. 09?
13. What is standard time? Where would you look to find the standard time of a place?
14. With the aid of a Nautical Almanac find the local mean times of sunrise and sunset on August 3, in latitudes $33^{\circ} 20' N.$, and $42^{\circ} 10' S.$ Find the duration of civil and nautical twilight after sunset on November 5, in latitude $47^{\circ} S.$
15. What is the rate of a chronometer or watch? How is it checked, and where is it recorded?
16. What time is recorded by signal clocks and ship's clocks? How are these times altered when a ship steams eastward or westward?

The Moon, Planets, and Stars

17. What is the approximate duration of a moon month? What are the phases of the Moon? What is meant by the age of the Moon? How can you tell whether the Moon on any night is waxing or waning? What approximate periods of moonlight could you expect on a clear night in Great Britain at (a) new moon, (b) first quarter, (c) full moon and (d) last quarter? Where would you find the times of moonrise and moonset for any particular day?
18. What is the difference between a planet and a star? In what part of the sky, and at what period of the day or night, would you look for Venus?
19. How can you identify the Pole Star on a clear night in Great Britain? How can you find the approximate direction of the South Pole on a clear night in Australia? If you saw the Pole Star at an altitude of about 35° above the horizon, what would be your approximate latitude? If you saw Orion's belt directly overhead, in about what latitude would you be?

CHAPTER XXVII

THE WEATHER

1. What is the purpose of a barometer?
2. What causes wind? How is a wind described and logged?
3. What is the Beaufort wind scale?
4. What is the value of knowing the temperatures of the air and surface sea water?

5. How is humidity measured? What is the value of knowing the humidity of the air?
6. Describe very briefly one way in which cloud is formed. What is fog?
7. Within what limits of visibility would you record (a) fog, and (b) mist?
8. At what time of the year is fog most likely, (a) in the open N. Atlantic, and (b) at Chatham?
9. What are the main differences between a depression and an anti-cyclone in the northern hemisphere? What kind of weather would you usually associate with each?
10. What is the value of local weather lore? Would local weather lore of the British Isles be applicable, say, in Canada or Australia?
11. Define climate.
12. Describe very briefly two of the following :—
Trade Winds, the Doldrums, Monsoons, the Westerlies.
13. What is a tropical storm? At what time of the year are tropical storms most prevalent in the northern hemisphere? Give two examples of the local names given to such storms?
14. During what times of the day approximately would you expect a land breeze and a sea breeze? In what parts of the world are they most prevalent?

Meteorological Instruments

15. What is the importance of taking regular and accurate readings of the barometer, hygrometer and sea thermometer?
16. Demonstrate your ability to read and correct the readings of a mercurial barometer. Demonstrate your ability to read a hygrometer and an aneroid barometer.
17. What would you infer if, on a fine day, the readings of the wet and dry bulb thermometers are found to be the same?

APPENDIX IV

CHAPTER XVIII

Rule of the Road, 1948 Regulations*

EXPLANATION OF THE INTERNATIONAL REGULATIONS FOR PREVENTING COLLISIONS AT SEA

THESE regulations were originally formulated and agreed to by the leading maritime nations in the early years of this century and were incorporated in International Law when they were ratified by the nations concerned in 1910. Since then they have commonly been known as "The 1910 Regulations".

In 1929, at an International Conference for the Safety of Life at Sea held in London, the 1910 Regulations were revised. These revised regulations, however, were never fully ratified by the nations concerned and so never became a part of International Law, although many of them were put into effect by several nations.

In 1948, at another International Conference for the Safety of Life at Sea held in London, the 1929 regulations were revised and it was decided to issue them as a new set of regulations called *The International Regulations for Preventing Collisions at Sea, 1948*; these have now been ratified by the nations concerned and so have become a part of International Law. They are enforced in all British vessels other than H.M. ships by the *Merchant Shipping Act*, and in H.M. ships by the *Queen's Regulations and Admiralty Instructions*.

The regulations consist of thirty-two rules, and apart from the *Queen's Regulations and Admiralty Instructions* they are set out fully in the *Admiralty Navigation Manual* and in Volume III of this manual.

In this chapter, which is intended to introduce the seaman to the "Rule of the Road" both at sea and in harbour and to explain to him its principles, only the more important rules have been included to avoid confusing him with too many minor details.

SCOPE OF THE REGULATIONS

The regulations should be obeyed by all vessels on the high seas. They are also applicable in territorial waters, and in waters connected with the open sea which are navigable by sea-going ships; in such waters where manoeuvring space is limited and vessels must of necessity pass close to one another, in channels, harbours and rivers for example, they may be qualified by local regulations.

The thirty-two rules are divided into the four following distinct parts:—
Part A—Preliminary and Definitions; Part B—Lights and Shapes; Part C—Steering and Sailing Rules; and Part D—Miscellaneous.

* The Rule of the Road at Sea as described in this appendix conforms to the *Regulations for Preventing Collisions at Sea, 1948*, and when these regulations are put into effect this appendix should be used instead of Chapter XVIII, which should then be cancelled.

The Steering and Sailing Rules provide for almost all occasions of two vessels approaching one another where risk of collision exists. They tell the seaman which vessel must give way, and describe the conditions under which he may expect the other vessel to keep clear of him.

The remaining rules prescribe the means whereby vessels which are fully manoeuvrable may be identified by night or in low visibility ; also the means whereby vessels with no power (or limited power) of manoeuvrability may be distinguished, by day or by night, or in low visibility, from those which are fully manoeuvrable. By these means (*i.e.* the display of lights and shapes and the making of sound signals) the seaman may know instantly whether to expect another vessel to obey the Steering and Sailing Rules or whether she is unable to do so. They also include sound signals to be made by vessels in various circumstances, signals to be made by vessels in distress to attract attention or summon assistance, and precautions to be taken by all vessels.

ORDER IN WHICH THEY AND OTHER TRAFFIC REGULATIONS ARE DESCRIBED

In the first part of this chapter are described the principles upon which the Steering and Sailing Rules are based, and some definitions are given of the terms used. Then follow Rules 16 to 30 of the *International Regulations for Preventing Collisions at Sea, 1948*, reproduced word for word. These rules deal chiefly with the Steering and Sailing Rules and the sound signals to be made by vessels when obeying them ; they are the most important rules of these regulations, and the seaman should know them thoroughly. At the end of the rules are given notes on their interpretation.

Next are described the navigation lights which should be displayed by vessels at night, with some general notes on navigation lights. Then follow remarks on lights and daymarks to be displayed in certain circumstances by vessels, with notes on their interpretation.

Next are described the sound signals prescribed by the regulations to be made by vessels in conditions of low visibility. Then follow other sound signals which may be made by vessels, some of which are authorised by the *International Code of Flag Signals* and others by local harbour regulations.

At the end of the chapter are given signals authorised by the regulations to be displayed by vessels in distress, and finally are included some miscellaneous signals which may be met with at sea.

PRINCIPLES OF THE STEERING AND SAILING RULES

The rules for a power-driven vessel meeting another power-driven vessel depend upon the relative bearing between the two ships, and are quite separate from the rules for a sailing vessel meeting another sailing vessel, which are governed by the direction of the wind.

The main principles upon which the Steering Rules for power-driven vessels are based are that :—

- (i) when two vessels approach end on to one another, each must give way to the other ;
- (ii) in all other circumstances where risk of collision exists one vessel holds her course and speed while the other gives way ;
- (iii) the vessel which is directed to give way does so by altering course, or reducing speed, or stopping, or going astern ;
- (iv) the vessel which is directed to give way should avoid crossing close

- ahead of the other ;
- (v) in a broad sense vessels keep to the right ;
 - (vi) vessels should always keep a proper look-out, exhibit the prescribed daymarks and lights, make the prescribed sound signals, and be handled in a seamanlike manner with due caution and consideration for others, especially in conditions of low visibility ;
 - (vii) if a collision appears probable each vessel must take whatever action is possible to avert it, even if such action involves a departure from the normal rules.

The principle on which the Sailing Rules are based is that the vessel which would lose more ground by an alteration of course is given right of way, a vessel beating to windward for example.

Risk of Collision

When two vessels appear to be on converging courses the possibility of collision depends upon their relative courses and speeds. The course and speed of one vessel is difficult to judge from another, and the only certain way of determining whether risk of collision exists is to take a compass bearing of the other vessel. If the bearing does not alter appreciably then risk of collision exists. If it "draws forward" the other vessel should cross ahead, and if it

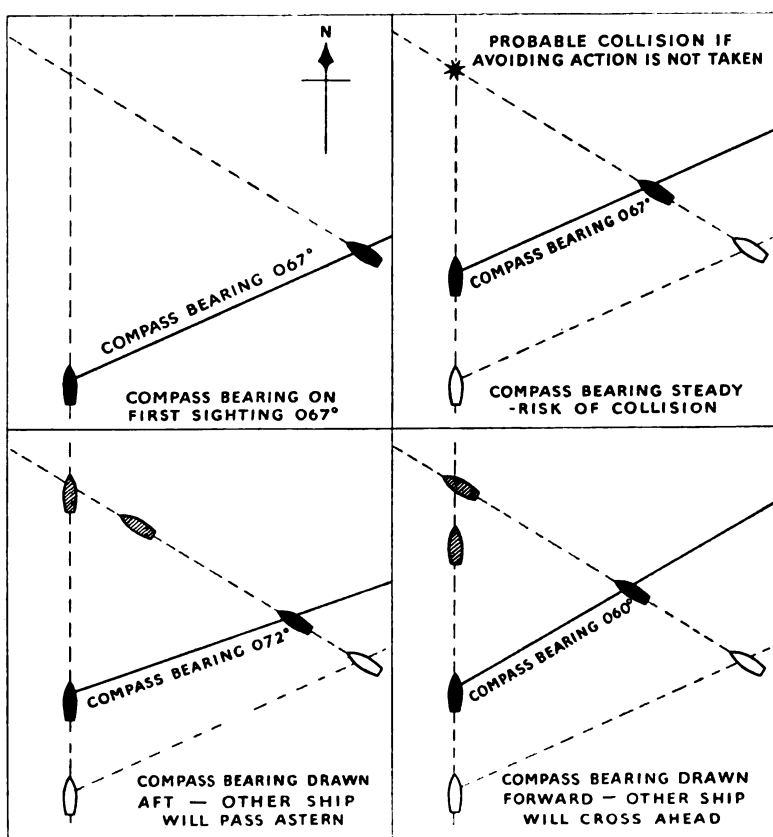


Fig. 319a. Risk of collision

“draws aft” she should pass astern. If a compass is not available relative bearings may be taken, but it should be borne in mind that a relative bearing will alter if your vessel yaws to either side of her course, and due allowance should be made for this.

The Giving-way Vessel

To determine whether you should give way to another power-driven vessel, divide your horizon into three arcs relative to your course. You must give way to any power-driven vessel approaching from within the starboard arc, except to an overtaking vessel which has moved into that arc from the overtaking arc. You do not give way to any power-driven vessel approaching from within the port arc. All power-driven vessels approaching you from within the overtaking arc keep clear of you. It should be borne in mind that where risk of collision exists the vessel which has right of way must not alter course, or increase or reduce speed, except to avoid navigational dangers or to take avoiding action if a collision appears probable. A vessel's course is deemed to be the course which she is endeavouring to steer, and due allowance must be made by the giving-way vessel for any yawing caused by weather or other circumstances.

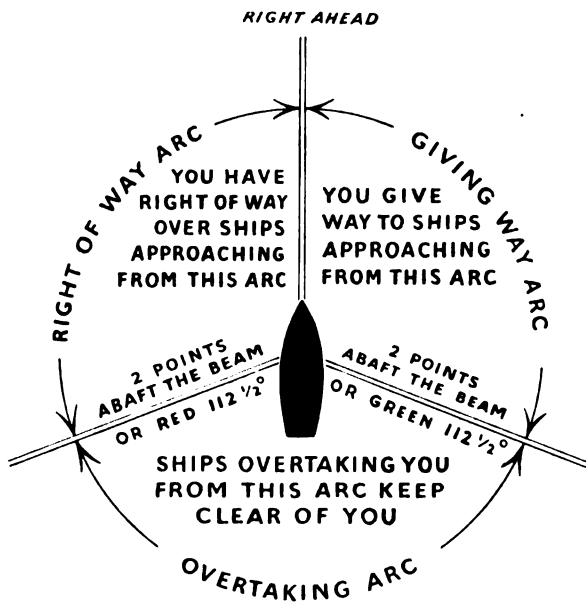


Fig. 320a. Relative arcs

Definitions

Before considering the Steering and Sailing Rules given on pages 811 to 817 the following definitions should be learned :—

- (i) The term power-driven vessel denotes any vessel which is mechanically propelled. It includes motor boats, diesel craft, and auxiliary craft (*i.e.* vessels which are propelled both by the wind and mechanical means).
- (ii) The term sailing vessel denotes any vessel which is propelled only by means of the wind and her sails.

- (iii) A vessel is said to be "under way" when she is not at anchor, or made fast to the shore or the bottom, or aground. Thus a vessel may be described as "under way, but stopped", or "under way and making way". All vessels under way are bound to obey the Steering and Sailing Rules unless they are "not under command", i.e. unless they are unable to manoeuvre for any reason.
- (iv) The term "seaplane" includes a flying boat and any other aircraft designed to manoeuvre on the water.

EXTRACTS FROM THE INTERNATIONAL REGULATIONS FOR PREVENTING COLLISIONS AT SEA (1948)

RULE 16

Speed to be moderate in fog, etc.

(a) *Every vessel, or seaplane when taxi-ing on the water, shall, in fog, mist, falling snow, heavy rainstorms or any other conditions similarly restricting visibility, go at a moderate speed, having careful regard to the existing circumstances and conditions.*

(b) *A power-driven vessel hearing, apparently forward of* her beam, the fog-signal of a vessel the position of which is not ascertained, shall, so far as the circumstances of the case admit, stop her engines, and then navigate with caution until danger of collision is over.*

Steering and Sailing Rules

Preliminary

1. In obeying and construing these Rules, any action taken should be positive, in ample time, and with due regard to the observance of good seamanship.
2. Risk of collision can, when circumstances permit, be ascertained by carefully watching the compass bearing of an approaching vessel. If the bearing does not appreciably change, such risk should be deemed to exist.
3. Mariners should bear in mind that seaplanes in the act of alighting or taking off, or operating under adverse weather conditions may be unable to change their intended action at the last moment.

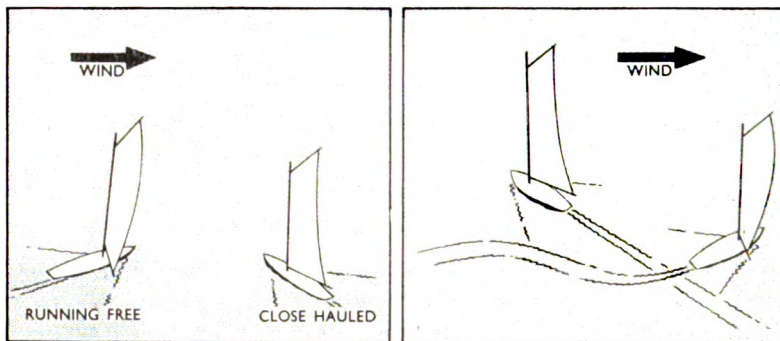
RULE 17

When two sailing vessels are approaching one another, so as to involve risk of collision, one of them shall keep out of the way of the other, as follows :—

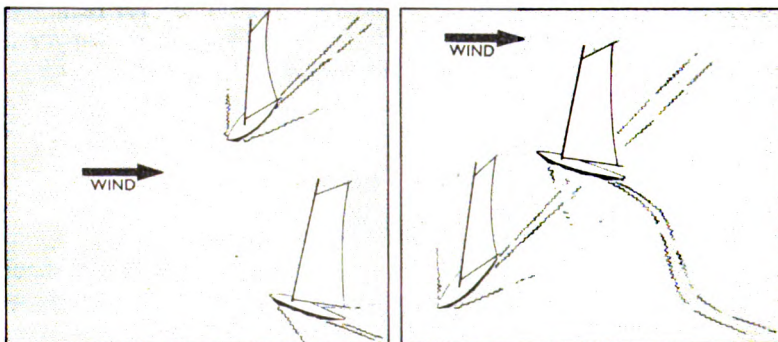
- (a) *A vessel which is running free shall keep out of the way of a vessel which is close-hauled.*
- (b) *A vessel which is close-hauled on the port tack shall keep out of the way of a vessel which is close-hauled on the starboard tack.*
- (c) *When both are running free, with the wind on different sides the vessel which has the wind on the port side shall keep out of the way of the other.*

* The use of the expression "forward of" instead of the seamanlike expression "before" is probably because these rules were finally drafted by lawyers and not by seamen. The seaman will find this unseamanlike term used again in Rule 24 (c).

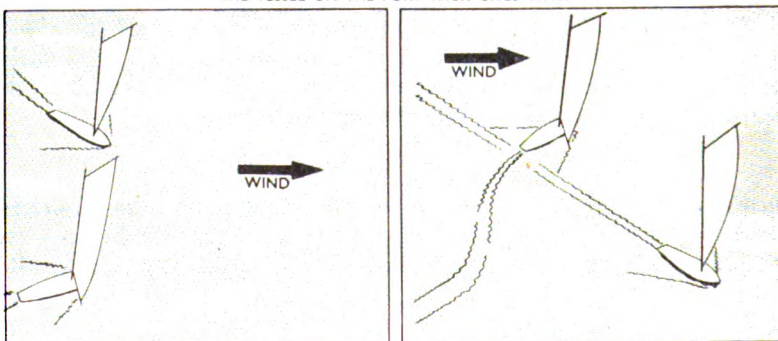
- (d) *When both are running free, with the wind on the same side, the vessel which is to windward shall keep out of the way of the vessel which is to leeward.*
- (e) *A vessel which has the wind aft shall keep out of the way of the other vessel.*



A SAILING VESSEL RUNNING FREE GIVES WAY TO ONE CLOSE HAULED.



TWO SAILING VESSELS CROSSING ON OPPOSITE TACKS.
THE VESSEL ON THE PORT TACK GIVES WAY.



TWO SAILING VESSELS, BOTH RUNNING FREE, WITH THE WIND ON OPPOSITE SIDES.
THE VESSEL WITH THE WIND ON HER PORT SIDE GIVES WAY.

Fig. 321a. Examples of the Sailing Rules

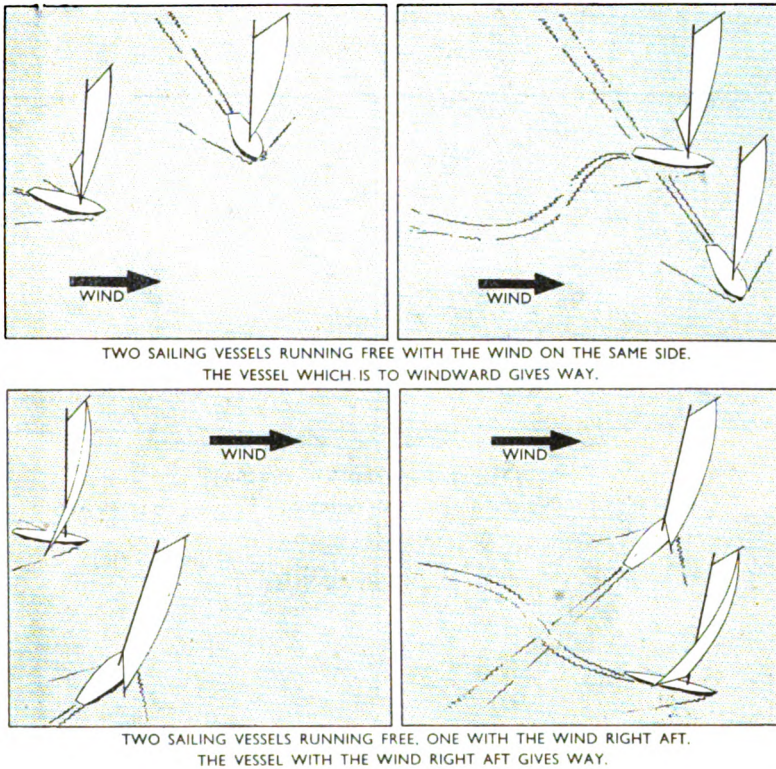
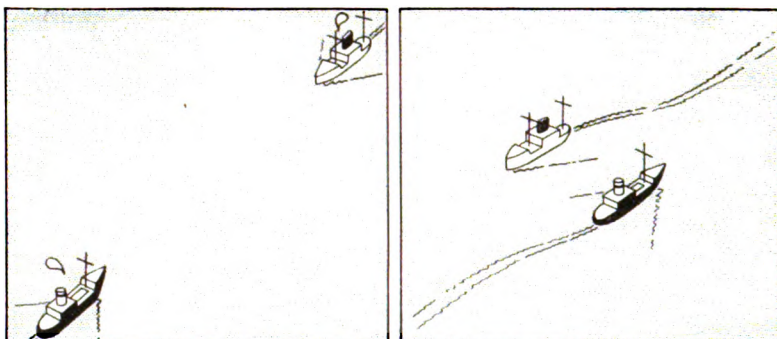


Fig. 321a. (cont.) Examples of the Sailing Rules

RULE 18

(a) When two power-driven vessels are meeting end on, or nearly end on, so as to involve risk of collision, each shall alter her course to starboard, so that each may pass on the port side of the other. This Rule only applies to cases where vessels are meeting end on, or nearly end on, in such a manner as to involve risk of collision, and does not apply to two vessels which must, if both keep on their respective courses, pass clear of each other. The only cases to which it does apply are when each of two vessels is end on, or nearly end on, to the other; in other words, to cases in which by day, each vessel sees the masts of the other in a line or nearly in a line, with her own; and by night to cases in which each vessel is in such a position as to see both the side-lights of the other. It does not apply, by day, to cases in which a vessel sees another ahead crossing her own course; or, by night, to cases where the red light of one vessel is opposed to the red light of the other, or where the green light of one vessel is opposed to the green light of the other, or where a red light without a green light or a green light without a red light is seen ahead, or where both green and red lights are seen anywhere but ahead.

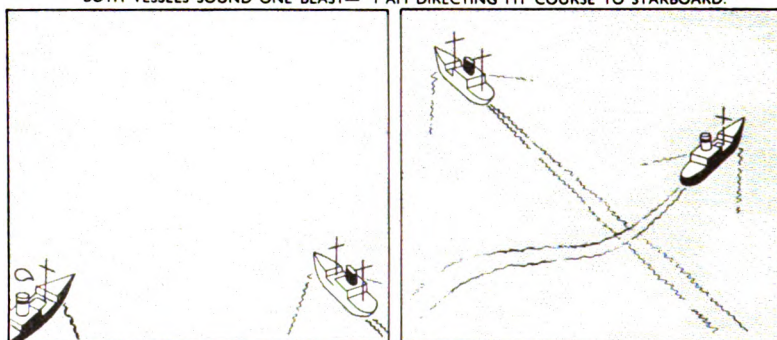
(b) For the purposes of this Rule and Rules 19 to 29 inclusive, except Rule 20 (b), a seaplane on the water shall be deemed to be a vessel, and the expression "power-driven vessel" shall be construed accordingly.



TWO STEAM VESSELS MEETING END-ON, OR NEARLY END-ON.

BOTH VESSELS ALTER COURSE TO STARBOARD.

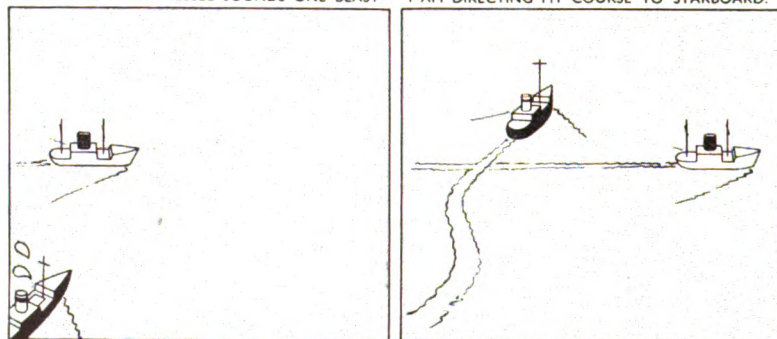
BOTH VESSELS SOUND ONE BLAST—"I AM DIRECTING MY COURSE TO STARBOARD."



TWO STEAM VESSELS CROSSING.

THE VESSEL WHICH HAS THE OTHER ON HER STARBOARD HAND GIVES WAY.

THE GIVING-WAY VESSEL SOUNDS ONE BLAST—"I AM DIRECTING MY COURSE TO STARBOARD."

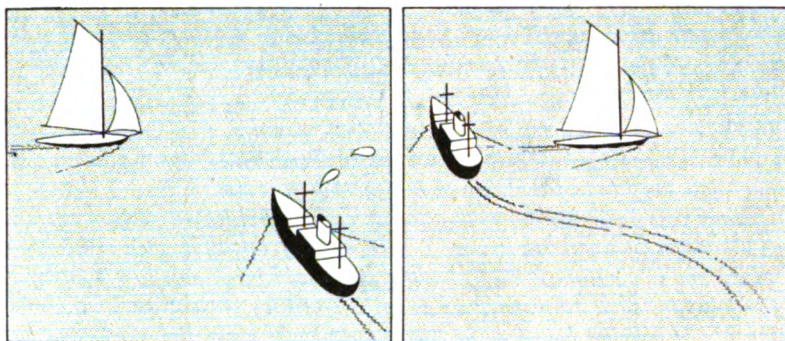


ONE STEAM VESSEL OVERTAKING ANOTHER.

OVERTAKING VESSEL KEEPS CLEAR OF THE OTHER.

OVERTAKING VESSEL SOUNDS TWO BLASTS—"I AM DIRECTING MY COURSE TO PORT."

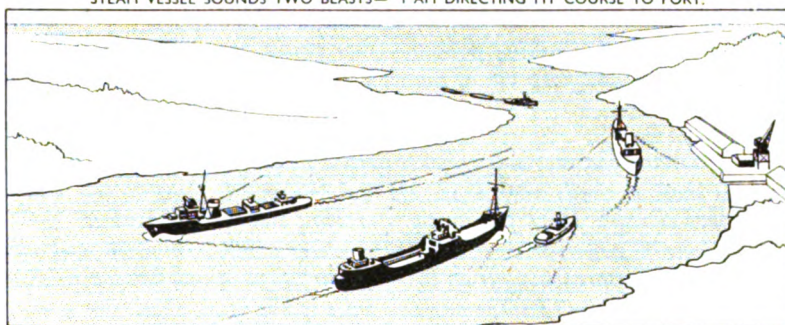
Fig. 322a. Examples of the Steering Rules



STEAM VESSEL CROSSING SAILING VESSEL.

STEAM VESSEL GIVES WAY.

STEAM VESSEL SOUNDS TWO BLASTS—"I AM DIRECTING MY COURSE TO PORT."



STEAM VESSELS KEEP TO THE RIGHT-HAND SIDE OF A NARROW CHANNEL.

Fig. 322a. (cont.) Examples of the Steering Rules**RULE 19**

When two power-driven vessels are crossing so as to involve risk of collision, the vessel which has the other on her own starboard side shall keep out of the way of the other ship.

RULE 20

(a) When a power-driven vessel and a sailing vessel are proceeding in such directions as to involve risk of collision, except as provided in Rules 24 and 26, the power-driven vessel shall keep out of the way of the sailing vessel.

(b) A seaplane on the water shall, in general, keep well clear of all vessels and avoid impeding their navigation. In circumstances, however, where risk of collision exists, she shall comply with these Rules.

RULE 21

Where by any of these Rules one of two vessels is to keep out of the way, the other shall keep her course and speed. When, from any cause, the latter vessel finds herself so close that collision cannot be avoided by the action of the giving-way vessel alone, she also shall take such action as will best aid to avert collision (see Rules 27 and 29).

RULE 22

Every vessel which is directed by these Rules to keep out of the way of another vessel shall, if the circumstances of the case admit, avoid crossing ahead of the other

RULE 23

Every power-driven vessel which is directed by these Rules to keep out of the way of another vessel shall, on approaching her, if necessary, slacken her speed or stop or reverse.

RULE 24

(a) Notwithstanding anything contained in these Rules, every vessel overtaking any other shall keep out of the way of the overtaken vessel.

(b) Every vessel coming up with another vessel from any direction more than 2 points ($22\frac{1}{2}$ degrees) abaft her beam, i.e. in such a position with reference to the vessel which she is overtaking that at night she would be unable to see either of that vessel's sidelights, shall be deemed to be an overtaking vessel; and no subsequent alteration of the bearing between the two vessels shall make the overtaking vessel a crossing vessel within the meaning of these Rules, or relieve her of the duty of keeping clear of the overtaken vessel until she is finally past and clear.

(c) If the overtaking vessel cannot determine with certainty whether she is forward of or abaft this direction from the other vessel, she shall assume that she is an overtaking vessel and keep out of the way.

RULE 25

(a) In a narrow channel every power-driven vessel when proceeding along the course of the channel shall, when it is safe and practicable, keep to that side of the fairway or mid-channel which lies on the starboard side of such vessel.

(b) Whenever a power-driven vessel is nearing a bend in a channel where a power-driven vessel approaching from the other direction cannot be seen, such vessel, when she shall have arrived within one-half mile of the bend, shall give a signal by one prolonged blast of her whistle, which signal shall be answered by a similar blast given by any approaching power-driven vessel that may be within hearing around the bend. Regardless of whether an approaching vessel on the farther side of the bend is heard, such bend shall be rounded with alertness and caution.

RULE 26

All vessels not engaged in fishing shall, when under way, keep out of the way of any vessels fishing with nets or lines or trawls. This Rule shall not give to any vessel engaged in fishing the right of obstructing a fairway used by vessels other than fishing vessels.

RULE 27

In obeying and construing these Rules due regard shall be had to all dangers of navigation and collision, and to any special circumstances, including the limitations of the craft involved, which may render a departure from the above Rules necessary in order to avoid immediate danger.

Miscellaneous

RULE 28

(a) When vessels are in sight of one another, a power-driven vessel under way, in taking any course authorised or required by these Rules, shall indicate that course by the following signals on her whistle, namely :—

One short blast to mean " I am altering my course to starboard ".

Two short blasts to mean " I am altering my course to port ".

Three short blasts to mean " My engines are going astern ".

(b) *Whenever a power-driven vessel which, under these Rules, is to keep her course and speed, is in sight of another vessel and is in doubt whether sufficient action is being taken by the other vessel to avert collision, she may indicate such doubt by giving at least five short and rapid blasts on the whistle. The giving of such a signal shall not relieve a vessel of her obligations under Rules 27 and 29 or any other Rule, or of her duty to indicate any action taken under these Rules by giving the appropriate sound signals laid down in this Rule.*

(c) *Nothing in these Rules shall interfere with the operation of any special rules made by the Government of any nation with respect to the use of additional whistle signals between ships of war or vessels sailing under convoy.*

RULE 29

Nothing in these Rules shall exonerate any vessel, or the owner, master, or crew thereof, from the consequences of any neglect to carry lights or signals, or of any neglect to keep a proper look-out, or of the neglect of any precaution which may be required by the ordinary practice of seamen, or by the special circumstances of the case.

RULE 30

Reservation of Rules for Harbours and Inland Navigation.

Nothing in these Rules shall interfere with the operation of a special rule duly made by local authority relative to the navigation of any harbour, river, lake, or inland water, including a reserved seaplane area.

REMARKS ON THE STEERING AND SAILING RULES—

RULES 17 to 28*

Sailing Vessels (Rule 17)

This rule has been the subject of controversy ever since it was conceived because nowhere in the regulations have the terms “running free”, “close hauled”, “starboard tack”, and “port tack” been defined. In the course of time, however, these terms have been defined in a broad sense by decisions given by judges of the Admiralty Court in cases resulting from collisions between sailing vessels, but it should be borne in mind that such definitions differ largely from those commonly used in sailing, and that they apply only to the provisions of these regulations.†

In so far as these regulations are concerned a sailing vessel is deemed to be :—

on the starboard tack when she is sailing with the wind on her starboard side, blowing from abeam or before her beam ;

on the port tack when she is sailing with the wind on her port side, blowing from abeam or before her beam ;

close-hauled when she is sailing with the wind on either side, blowing from abeam or before her beam ;

running free when she is sailing with the wind on either side, blowing from abaft her beam.

* See also the chapter on “ Officer of the Watch at Sea ” in Volume III of this manual.

† For definitions of sailing terms as commonly applied see pages 281 to 283.

Power-driven Vessels (Rules 18 to 27)

When obeying the Steering and Sailing Rules, the following points should be borne in mind :—

- (i) If yours is the giving-way vessel, always give the other vessel as wide a berth as circumstances allow. It is bad seamanship and bad manners to pass close aboard another vessel.
- (ii) If yours is the giving way vessel your avoiding action should be made in such a manner as to leave no doubt of your intentions in the mind of the person in charge of the other vessel. You should therefore :—
 - (a) take avoiding action in plenty of time ;
 - (b) when altering course make a sufficiently large initial alteration to make your intentions clear ;
 - (c) steady on your new course without undue yawing ;
 - (d) make the appropriate sound signal.
- (iii) When another vessel is approaching, steer as steady a course as possible and make allowances for the other vessel yawing. A vessel approaching nearly end on, on an opposite course, may appear end on now and again because she is yawing. Under such circumstances she should be treated as approaching end on, and you should alter your course to starboard to give her as wide a berth as practicable.
- (iv) In a narrow channel keep to that side of the channel which is on your starboard hand.

**REMARKS ON SOUND SIGNALS FOR VESSELS IN SIGHT OF
EACH OTHER—RULE 28**

- (i) Whenever a power-driven vessel takes avoiding action she must, by Rule 28, indicate that action at the time it is taken by making the appropriate sound signal. The "short blast" may be made on a steam whistle, siren, klaxon horn, or other similar sound-producing instrument. Also, it is customary for all power-driven vessels within sight of and close to other vessels to make these signals when altering course or going astern when manoeuvring or in the process of normal navigation, and particularly when there is another vessel close astern.
- (ii) It is the custom to give an additional interpretation to the signal of three short blasts, viz. : "My vessel is making way astern".
- (iii) The rule requires these signals to be made by "a power-driven vessel underway, in taking *any course authorised or required by these rules*"; it should be borne in mind, therefore, that the provisions of this rule apply not only to the ship which has to give way, but also to the ship which, under Rule 27, should hold her course but has to alter course to avoid some navigational danger ; and that it also applies to any ship which, under Rules 21 and 29, has to take avoiding action to avert an imminent collision.
- (iv) The rule requires these signals to be made "when vessels are *in sight* of one another". The signals are not made in conditions of low visibility when ships, though close to each other, cannot see one another, because there is then a danger of such signals drowning, or being confused with, the fog signals of nearby shipping and of navigational

marks. The signals are sometimes omitted when an alteration of course is made by ships which are within sight of each other, but are so far apart as to be outside the sound range of the siren, but it is prudent in these circumstances always to make the appropriate signal.

- (v) There is always a risk of a steam siren not working efficiently at first, owing to steam having condensed in the pipe. Great care must therefore be taken that another vessel does not interpret your signal incorrectly. For example, when wishing to sound two short blasts the first of these might be choked and the second quite correct, so that the other vessel might then interpret the signal as one short blast. If, therefore, choking does occur, repeat your signal a moment later; but, best of all, keep your siren clear.

NAVIGATION LIGHTS

Any vessel which is under way between the times of sunset and sunrise must exhibit the recognised "navigation lights", so that her classification, position, and course may be identified. The navigation lights which should be exhibited by a power-driven vessel 150 feet or more in length are illustrated in Plate 6a and described below. Navigation lights for smaller power-driven vessels, and those for sailing vessels, are described below and illustrated in the "Table of Lights and Daymarks" Plate 7a. It should be noted that the arcs over which the navigation lights show correspond with the "right-of-way", "giving-way", and "overtaking" arcs illustrated in Fig. 320a, and it is by this means that the course of a vessel may be estimated at night.

Navigation Lights of a Power-driven Vessel 150 feet or more in Length (Plate 6a)

- (i) *Side-lights, sometimes called bow-lights; visible at least 2 miles on a clear night.* On the starboard side a green light, showing from right ahead to 2 points abaft the beam, i.e. from zero to green $112\frac{1}{2}$. On the port side a red light, showing from right ahead to 2 points abaft the beam, i.e. from zero to red $112\frac{1}{2}$.
These lights are screened so that they cannot be seen from the opposite bow.
- (ii) *Overtaking light, sometimes called stern light; visible at least 2 miles on a clear night.* At the stern, a white light at about the same height as the side-lights, showing from 2 points abaft the starboard beam, around the stern to two points abaft the port beam.
- (iii) *Steaming lights, sometimes called masthead lights* or range lights; visible at least 5 miles on a clear night.* Two white lights placed well above the hull on the fore-and-aft midship line, at least 45 feet apart, and known respectively as the fore steaming light and the after, or main, steaming light. The forward light must be at least 20 feet above the hull, and if the vessel has a greater beam than 20 feet it must be at a height not less than her beam, but it need not be higher than 40 feet. The after light must be at least 15 feet higher than the forward light. One of the lights must be on or before the foremast,

* This term is apt to be confused with the masthead signalling lights fitted in warships, and it is not therefore used in the Royal Navy.

or if the vessel has no foremast it must be in her fore part ; the other light may be before or abaft this light.

Each light must show from 2 points abaft the starboard beam, around the bows to 2 points abaft the port beam.

Navigation Lights of Small Power-driven Vessels.

- (i) A power-driven vessel of under 40 tons gross tonnage need only carry one steaming light (visible at least 3 miles on a clear night) in the fore part of the vessel, not less than 9 feet above her gunwale, and side-lights (visible at least 1 mile on a clear night) not less than 3 feet below the steaming light. Her side-lights may be of the type already described, or in the form of a "combined lantern" showing a green and a red light over their respective arcs. She should also carry, or show, an overtaking light.
- (ii) A small power-driven boat, such as a ship's boat or a harbour craft, may carry her steaming light less than 9 feet above her gunwale, but it must be higher than her side-lights or combined lantern.

Navigation Lights of Sailing Vessels

- (i) All sailing vessels of over 20 tons gross tonnage carry only side-lights and an overtaking light, as prescribed for steam vessels of over 150 feet in length.
- (ii) A sailing vessel of less than 20 tons gross tonnage may carry a combined lantern instead of the normal side-lights. If it is impracticable to fix the combined lantern it should be kept lighted and ready for use, and be exhibited over the correct arcs in sufficient time to prevent a collision.

Navigation Lights for Small Pulling Boats Under Oars or Sail

Such boats are required to carry only an all-round white light, which should be exhibited in time to prevent a collision. A warship's boat under oars carries this light on her foremost awning stanchion.

Remarks on Exhibition of Navigation Lights

Navigation lights are shown from sunset to sunrise by all vessels under way. A ship getting under way after sunset will switch off her anchor lights and switch on her navigation lights at the moment when the anchor is broken out of the bottom, or when the slip-rope clears the buoy, or when the last berthing hawser is cast off.

When coming to an anchor or securing to a buoy or alongside between sunset and sunrise a vessel switches off her navigation lights and switches on her anchor lights as the anchor is let go, or as the picking-up rope is brought to the capstan, or when the first berthing hawser is made fast.

Navigation lights should be placed well clear of the vessel's normal lighting and so that their arcs of visibility are not obstructed by rigging or other fittings ; particular care should be taken when placing the side-lights to ensure that each is so screened that when viewed from ahead it cannot be seen from the opposite bow. Care must also be taken to ensure that no lights are visible

from outboard which might be mistaken for the navigation lights ; any curtains provided for the side-scuttles should not be of red, green or blue materials because a light shining through them may be mistaken for one of the side-lights.

Navigation lights are usually electric, but oil-burning or battery-operated lights are provided for use in the event of an electricity failure. When at sea by night these secondary lights are kept lit, or ready for immediate use, and stowed in a handy place out of sight from outboard. If the normal navigation lights fail, the secondary lights are placed or hoisted into position. At sea, navigation lights and " not under command " lights should always be tested before sunset. At sunset, when navigation lights are switched on, they should be inspected to see that they are burning brightly, and at the same time the secondary navigation lights should be lit, or tested, and stowed ready for immediate use ; thereafter, during the night, the navigation lights should be inspected at least once every watch to ensure that they are burning with the required brilliance.

The electric circuits of the navigation lights of a warship are fitted with resistances to enable them to be dimmed to the required minimum brilliance in wartime.

A warship may be equipped with a powerful group-light, known as the " fog light ", which shows astern. This is switched on in fog to enable a ship astern to keep station.

A warship may also be equipped with a " shaded stern light ". This is a dim blue light which shines over a restricted arc, and by which a ship astern keeps station in wartime on dark nights when ships are darkened and not burning navigation lights.

Remarks on Sighting Navigation Lights

At night the direction in which a power-driven vessel is steering may be judged by the number of her navigation lights which are visible from any one direction, and by their positions relative to each other and to the vessel.

Because the steaming lights are the more brilliant they will usually be sighted on a clear night before the side-lights. If the steaming lights are in line the vessel will be end on ; if the higher light is to the right of the lower, she will be going from right to left ; and if the higher light is to the left of the lower, she will be going from left to right.

If a vessel's steaming light and starboard side-light only are sighted anywhere to starboard, she should pass clear to starboard, or astern. Similarly, if her steaming lights and port side-light only are sighted anywhere to port, she should pass clear to port or astern. These remarks only apply to vessels which are not close aboard one another.

If a vessel's steaming lights and port side-light only are sighted to starboard and before 2 points before the beam, she will be on a converging course. Similarly, if her steaming lights and starboard side-light only are sighted to port and before 2 points before the beam, she will also be on a converging course. If these lights are sighted abaft 2 points before the beam, the vessel may be on a converging, a parallel, or a diverging course.

If one white light by itself is sighted it may be an overtaking light, and if so the sighting vessel will be in the overtaking sector of the other. If it is sighted before 2 points before the beam the other vessel may be on a converging, a

parallel, or a diverging course. If the light is sighted abaft two points before the beam the other vessel will be on a diverging course.

These remarks can be simply demonstrated by cutting out of paper the plan outline of a ship, marking thereon the visibility arcs of her navigation lights, and then placing this model on various courses and relative bearings.

Different Interpretations of a Single White Light Sighted at Sea

No lights met with at sea are capable of so many different interpretations as a single white light.

It may be :—

- (i) a vessel's anchor light ;
- (ii) the overtaking light of a vessel ;
- (iii) the single steaming light of a small power-driven vessel with her side-lights not yet in sight ;
- (iv) the light of a small boat under oars or sail ;
- (v) the light of a fishing vessel with nets or lines extending horizontally 500 feet or less which has not yet displayed her second white light ;
- (vi) the light of a sailing pilot vessel on her station, which has not yet shown her side-lights, and whose flare has not yet been seen ;
- (vii) the light of a sailing trawler which has not yet shown a flare ;
- (viii) a light on shore ;
- (ix) a bright star just above the horizon.

It is obvious that the examples (ii) and (v) are very different, both as regards the action it will be necessary to take and the time when such action will be necessary. It is well always to be prepared for prompt and most pronounced avoiding action, bearing in mind the area the ship is in at the time and the consequent likelihood of encountering such cases. It is not likely, for example, that a white light sighted in the middle of the Atlantic will be anything but (ii) or (ix), but if it were sighted in the Thames Estuary it might be any of the examples quoted above, except perhaps (vi).

RULES CONCERNING DAYMARKS AND LIGHTS

Any vessel not under way, or which if under way is unable to obey the Steering and Sailing Rules, either through force of circumstances or the nature of the duties on which she is engaged, is bound to exhibit by day certain shapes or flags called " daymarks ", and by night certain lights, in order to distinguish her from vessels under way and under full powers of manoeuvrability. Illustrations of these daymarks and lights are given in Plates 7a to 13a and the following information is given in amplification of them.

Warships at Anchor

By day a warship does not normally hoist a black ball when at anchor, but the fact that she is at anchor, or made fast to the shore or to a buoy, may be indicated by her jack flying from her jackstaff. On occasions of celebration, however, warships in an anchorage may be ordered to dress ship ; those at anchor dress overall with flags, and those under way fly a jack, masthead ensigns, and an ensign at the stern.

By night the anchor lights of a warship are usually displayed on her ensign and jack staffs. In accordance with naval custom a British flagship at anchor displays, in addition to her anchor lights, a white top-light on the after side of her mainmast showing over an arc of 180° from beam to beam through right astern, and one, two, or three all-round white lights placed athwartships on her after superstructure. At sea a British flagship or the ship of the senior officer of a squadron or flotilla may display the top-light in addition to her navigation lights.

Vessels Towing

The regulations do not give the right of way to a vessel which is towing, but it is the practice among seamen, and a sign of good sea manners, for other vessels to keep clear of her.

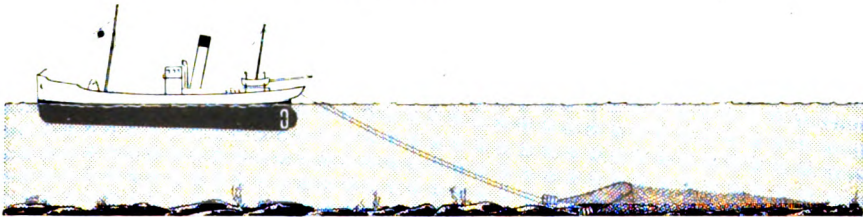
Vessels Not Under Command

A vessel is said to be "not under command" when she is not under full powers of manoeuvrability, and other vessels should keep clear of her. A vessel may not be under command for many different reasons, and her daymarks and lights should not be interpreted as signals indicating distress.

Fishing Vessels

For the purpose of these regulations vessels engaged in fishing are divided into the following four categories :—

- (i) vessels "trolling", *i.e.* towing light lines with hooks attached to them ;
- (ii) vessels engaged in trawling ;
- (iii) vessels fishing with nets or lines (except those trolling or trawling) whose gear extends horizontally 500 feet or less ;
- (iv) vessels fishing in a similar manner to (iii) above, but whose gear extends horizontally more than 500 feet.



(i) A TRAWLER TRAWLING



(ii) A DRIFTER LYING TO HER NETS

Fig. 323a. Methods of fishing

Fishing vessels when not fishing, and those which are trolling, show the normal lights or shapes prescribed for similar vessels of their type and tonnage. Fishing vessels when fishing (other than those which are trolling) can be distinguished by the lights and shapes described and illustrated on Plates 10a and 11a. Vessels fishing at anchor display the normal lights or shapes prescribed for similar vessels of their type and tonnage in addition to their special fishing lights or shapes. In addition to the special lights they are required to display vessels when fishing may use "working lights", and may burn a white flare or make a distinctive sound signal to attract the attention of an approaching vessel.

Rule 26 lays down that all vessels not engaged in fishing shall when under way, keep out of the way of any vessels fishing with nets, lines or trawls. A vessel which alters course to avoid a fishing vessel must ensure that she steers well clear, not only of the fishing vessel but also of her outlying gear (see Fig. 323a).

Seaplanes

A seaplane under way on the water is deemed to be a power-driven vessel in so far as the Steering and Sailing Rules are concerned, and she must take the appropriate avoiding action. It should be borne in mind, however, that an aircraft cannot go astern, and may be unmanoeuvrable when about to take-off or just after alighting, or in a high wind. It is therefore prudent as well as good manners to keep clear of the path of an aircraft which is about to land or take-off, and to navigate in her vicinity with due regard for her limited powers of manoeuvrability.

Miscellaneous Harbour Regulations

The *Regulations for Preventing Collisions at Sea* are observed generally by all vessels when navigating or manoeuvring in harbours, rivers, lakes or inland waters but in these waters they may be modified to suit local conditions, as provided for by Article 30 of the Regulations. The local regulations of one port may differ considerably from those of another, even when they apply to vessels of similar type in similar circumstances and even when the ports are situated close to one another; a dredger moored in Portsmouth Harbour, for example, displays very different lights and daymarks to those displayed by a dredger moored only eight miles away in Southampton Water. Before entering a harbour the seaman should therefore consult the relevant *Sailing Directions* and the current *Notices to Mariners* (particularly No. 1 of each year) in which the more important local traffic rules of a port are usually given, and he should also ascertain the seaward limits within which such rules are applicable; as soon as possible after entering the harbour he should obtain a copy of the local port regulations. Some fairly common rules observed by vessels in harbours and some examples of lights and daymarks displayed by vessels and craft in harbours are given below. Some are authorised by local regulations, and some by the *International Code of Flag Signals*.

VESSELS HAVING RIGHT OF WAY

An important rule in force in nearly all harbours is that ships or craft crossing the harbour must keep out of the way of ships entering or leaving it, that outgoing ships have right of way over incoming ships, and that ships going downstream have right of way over ships going upstream.

VESSELS TO BE PASSED AT SLOW SPEED

Vessels such as dredgers, salvage vessels and mooring vessels, may require other vessels passing them to do so at slow speed ; if so they fly the International Code Signal *T.E.* This signal may also be flown by a ship berthed alongside or it may be flown on the banks of a river or a channel.

Boats and vessels must pass at slow speed any place where divers are at work. The presence of divers is commonly indicated by a red flag flown in a ship or on shore and also in the diving boat. In H.M. ships it is a triangular flag and it is flown at the yard-arm on the side on which the divers are at work.

SHIPS EMBARKING OR DISEMBARKING EXPLOSIVES, OIL FUEL OR PETROL

Ships embarking or disembarking explosives should fly at the yard-arm Flag B (red burgee) of the *International Code of Signals*. This flag is also flown by H.M. ships when embarking or disembarking oil fuel or petrol.

SHIPS CARRYING DANGEROUS CARGOES

Daymarks and lights which may be displayed by ships in harbour which are carrying dangerous cargoes, such as explosives and petrol, are prescribed by local port regulations, and may therefore vary from port to port. A common daymark for ships carrying explosives, whether at anchor or underway, is a rectangular red flag usually flown at the fore masthead, and a common daymark for ships carrying petrol is a rectangular red flag with a circular white centre also usually flown at the fore masthead. It is common for both types of ships to display an all-round red light, at night, above the riding light when at anchor, and at the fore masthead when under way in addition to the navigation lights.

DREDGERS

Lights and daymarks displayed by dredgers are prescribed by local port regulations, and they may therefore differ from port to port.

A dredger moored in the fairway of one of H.M. dockyard ports, displays by night amidships, three all-round white lights in the form of a triangle, apex up, in addition to her anchor lights, in which case a vessel may assume it is safe to pass the dredger on either side. If the fairway on one side or other of the dredger is obstructed, the white light of the triangle on the dredger's obstructed side is replaced by a red light. By day the three white lights are replaced by three black balls, and a red flag replaces the red light on an obstructed side. In low visibility the dredger sounds at intervals of not more than one minute :— a gong rung rapidly for about 5 seconds.

FERRIES

Lights and daymarks displayed by ferries plying across a harbour are prescribed by local port regulations, and they may therefore differ from port to port. It is usual for ferries to give way to vessels entering or leaving harbour.

Ferries in H.M. dockyard ports which are drawn by chains from one landing to the other carry by night four lights, one at each corner, showing white ahead and astern, and red on the beam, visible 2 miles.

H.M. SHIPS ENTERING OR LEAVING ONE OF H.M. DOCKYARD PORTS

When ships over a certain tonnage are entering or leaving, or are under way in, the ports of Chatham, Sheerness, Portsmouth, Portland, Devonport, Plymouth, Rosyth and Pembroke, the following signals are to be displayed :—

By Ships Entering, Leaving, or Under Way :—

By day—Flags ZV.

By night—a red light at the masthead.

By Other H.M. Ships Present :—

Ships in certain berths, as detailed in local orders, fly Flags ZU as a warning to other vessels under way. It is the custom in H.M. ships to hoist the ensign at the peak if another ship is under way in harbour before Colours or after Sunset, if it is light enough for it to be seen.

MODERN BRITISH AIRCRAFT CARRIERS

Some modern British aircraft carriers when at anchor may exhibit the following anchor lights instead of the normal anchor lights :—

four white lights, one at each bow and one at each quarter, each visible over an arc of at least 180° ; the two forward lights on a level not more than 5 feet below the flight deck, and the two after lights on a level not less than 15 feet below the forward lights.

SOUND SIGNALS FOR USE IN LOW VISIBILITY

In low visibility such as occurs in fog, mist, snow, or heavy rain, a vessel under way must, both by day and at night, moderate her speed and sound the prescribed signals for warning other vessels of her presence or her approach and informing them of her category. *If a power-driven vessel hears the sound signal of another vessel before her beam she should stop engines and proceed with caution until danger of collision is over.*

The sound signals for low visibility are shown in the plates of " Lights and Daymarks " following this page, and are also given below. The signals prescribed for vessels under way must be given :—

- (i) by power-driven vessels on the whistle or siren ;
- (ii) by sailing vessels on the foghorn ;
- (iii) by vessels towed on the whistle, siren or foghorn.

The words " prolonged blast " mean a sound of between 4 and 6 seconds duration. It should be noted that a foghorn is worked by hand or blown by a man, and its sound differs from, and is not so loud as, that of a siren worked by electricity, steam or compressed air. The sound of a foghorn usually indicates the presence of a sailing vessels or a vessel being towed.

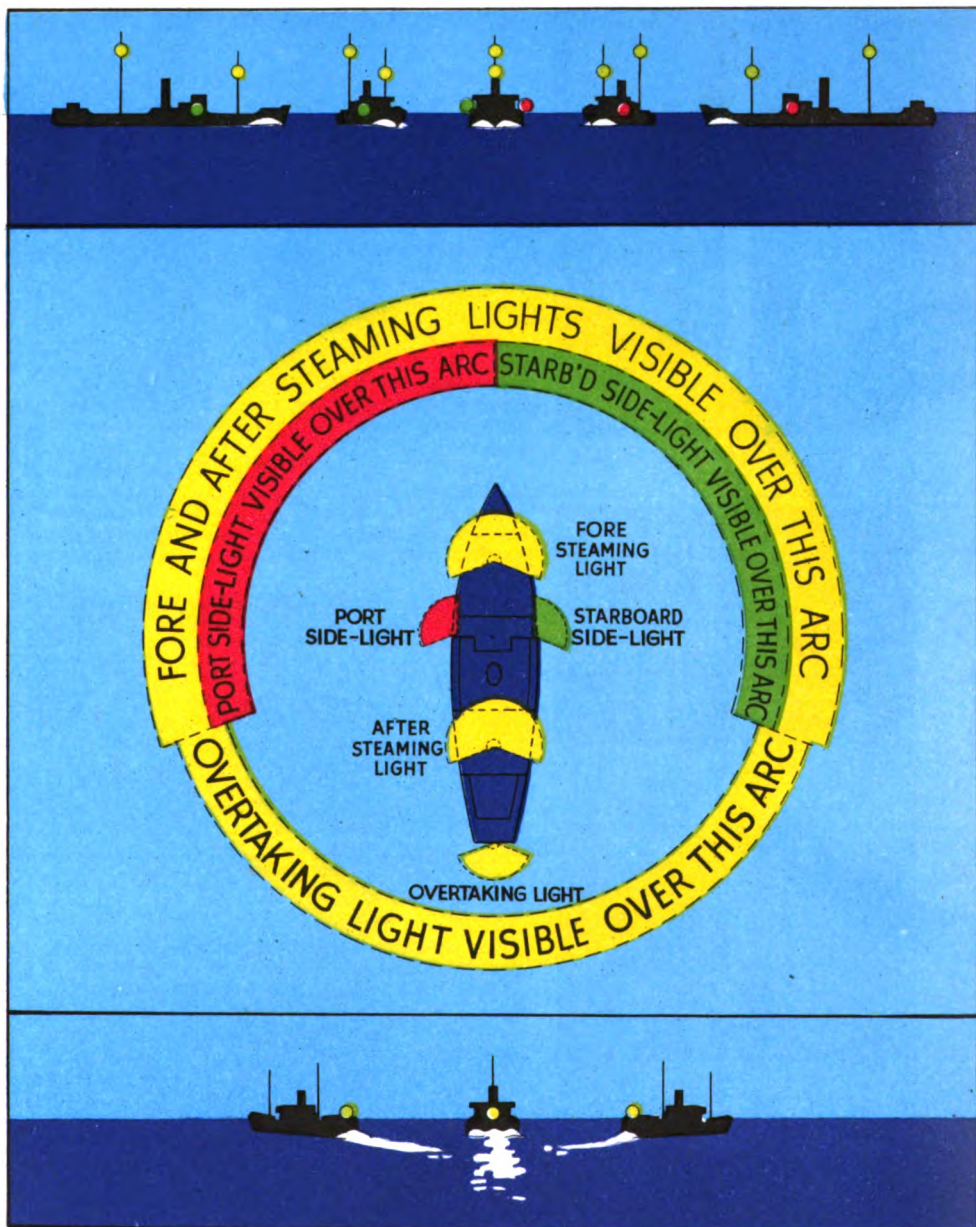
Signals on a Whistle or Siren at intervals of not more than TWO minutes

<i>Signal</i>	<i>Signification</i>
One prolonged blast	power-driven vessel under way and having way upon her.
Two prolonged blasts	power-driven vessel under way, but stopped and having no way on.

Signals on a Whistle, Siren or Foghorn at intervals of not more than ONE minute

<i>Signal</i>	<i>Signification</i>
One prolonged blast followed by two short blasts	a vessel under way but not under command ; a vessel towing ;

[Continued on page 827



NAVIGATION LIGHTS OF A POWER-DRIVEN VESSEL,
150 FEET OR MORE IN LENGTH

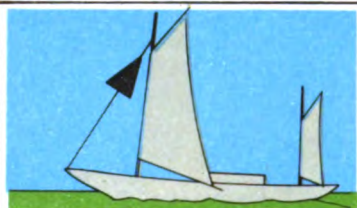
LIGHTS, DAYMARKS AND FOG SIGNALS OF VESSELS



Sailing vessel under way at night ; bows on.

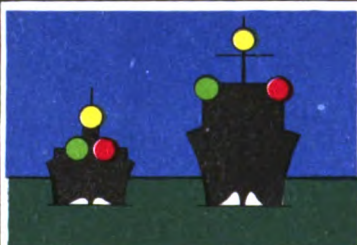
A sailing vessel under way at night carries side-lights or a combined lantern, and an overtaking light.

In low visibility, day or night, sailing vessels under way sound the following signals on the foghorn at intervals of not more than one minute :—
one blast —vessel on the starboard tack ;
two blasts —vessel on the port tack ;
three blasts—vessel running with the wind abaft the beam.



Side view of vessel under sail and mechanical power, by day.

A vessel proceeding under sail *and* mechanical power by day carries where it can best be seen a black cone, hoisted point uppermost.



Small power-driven vessel, and warship, under way, at night ; bows on.

A small power-driven vessel less than 40 tons gross tonnage, under way at night, may carry only a fore steaming light, an overtaking light, and a combined lantern.

A warship without a mainmast, under way at night, may carry only a fore steaming light, an overtaking light, and side-lights.

In low visibility, day or night, power-driven vessels under way sound the following signals on the whistle or siren at intervals of not more than 2 minutes :—
if making way—one long blast ;
if stopped —two long blasts.



Vessel 150 feet or more in length, at anchor, at night.

Any vessel at anchor, if 150 feet or more in length, carries by night two all-round white lights, viz., a "riding light", on her fore stay, and a stern light aft.

Vessels under 150 feet in length carry only a riding light.

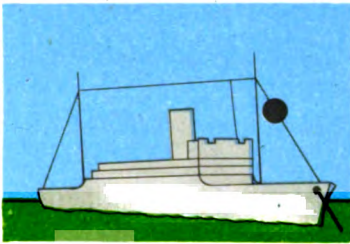


Flagship of an Admiral, at anchor, at night.*

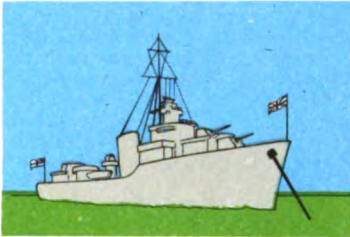
A warship at anchor by night carries her riding light and stern light at the trucks of her jack staff and ensign staff respectively. A flagship may carry, in addition to her riding light and stern light, a top-light and poop lanterns*. The number of poop lanterns indicates the rank of the admiral, viz., one for a Rear-Admiral, 2 for a Vice-Admiral and 3 for an Admiral.

*This is a custom for H.M. ships only.

LIGHTS, DAYMARKS AND FOG SIGNALS OF VESSELS



Vessel at anchor, by day.



Warship at anchor, by day.*

A vessel at anchor displays by day a black ball in place of her riding light.

A warship at anchor by day does not display a black ball but usually flies a jack at her jack staff in addition to the ensign at her ensign staff from 0800 or 0900 to sunset.*

In low visibility, day or night, a power-driven or sailing vessel at anchor sounds, at intervals of not more than one minute :—

a bell rung rapidly for about 5 seconds.

A vessel over 350 feet in length must ring a bell forward and a gong (or other such instrument) aft ; the tone of the gong (or instrument) must be distinct from that of the bell.

A vessel at anchor may sound, in addition to these sound signals, a short blast, a long blast and a short blast, in succession on her siren, to give warning of her position, and of the possibility of collision to an approaching vessel.†



Vessel towing another at night ; length of tow less than 600 feet.

A power-driven vessel towing or pushing a vessel at night, when the length of the tow is less than 600 feet, carries her side-lights, overtaking light and fore steaming light, and an additional steaming light close below, and in line with, her fore steaming light.

If the length of the tow exceeds 600 feet, the towing vessel must carry another steaming light close above, and in line with, her fore steaming light (making 3 in all).

The carrying of the after steaming light by the towing vessel is optional, and in place of her overtaking light she may display a small white light, not visible before the beam, for the vessel being towed to steer by.

The vessel being towed carries side-lights and an overtaking light, but if more than one vessel is being towed, all but the last vessel in tow may display, instead of an overtaking light, a small white light not visible before the beam.

A vessel being pushed carries side-lights at her forward end. Any number of vessels pushed ahead in a group are lighted as one vessel.



Vessel towing more than one vessel at night ; length of tow over 600 feet.

In low visibility, day or night, a power-driven vessel towing sounds the following signal on her siren or whistle at intervals of not more than one minute :—

one long blast followed by two short blasts.

A vessel towed, or if more than one vessel is towed only the last vessel in tow, sounds the following signal on the whistle or foghorn immediately after the signal made by the towing vessel :—

one long blast followed by three short blasts.

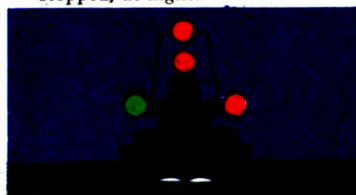
*This is a custom for H.M. ships only.

†See also the letter " R " under the heading " Signals Authorised by the International Code of Signals " in this chapter.

LIGHTS, DAYMARKS AND FOG SIGNALS OF VESSELS



Vessel not under command and stopped, at night.



Vessel not under command but making way, at night.



Vessel not under command, by day.

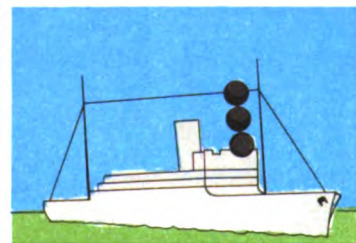
A vessel under way at night but not under command hoists two all-round red lights, one above the other, visible 2 miles, and dowses her steaming lights; if she is making way through the water she burns her side-lights as well. By day, a vessel not under command hoists two black balls.

In low visibility, day or night, a vessel not under command sounds, at intervals of not more than one minute :—

one long blast followed by two short blasts.



Vessel aground, by night.



Vessel aground, by day.

A vessel aground displays the following lights or daymarks :—

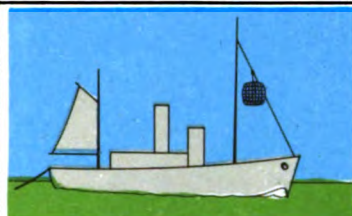
by night, two all-round red lights one above the other and her anchor lights;

by day, three black balls, one above the other.

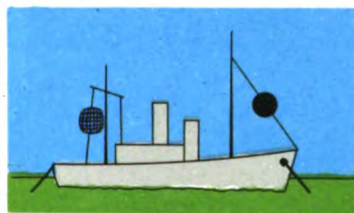
In low visibility, day or night, a vessel aground must make the following sound signal at intervals of not more than one minute :—

the fog signal for a vessel at anchor, preceded and followed by 3 separate and distinct strokes on the bell.

LIGHTS, DAYMARKS AND FOG SIGNALS OF VESSELS



A vessel under way by day, trawling or fishing with gear extending from her 500 feet or less.



A vessel fishing at anchor by day, with gear extending from her 500 feet or less. The basket indicates the direction of her gear from her anchor ball.

The shapes and lights prescribed for vessels engaged in fishing must be visible on a clear day or night at a distance of at least two miles.

A vessel fishing by day (except one which is trolling) displays a basket in addition to any other shape prescribed for her.

A vessel fishing at anchor, by day hoists her anchor ball in addition to any shape prescribed for her, and by night displays her riding light in addition to any lights prescribed for her.

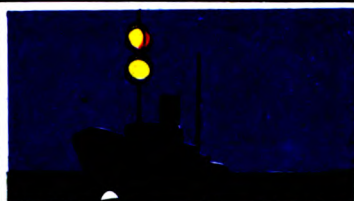
If a vessel when fishing becomes fast by her gear to a rock or other obstruction she must :—

- (i) by day haul down her basket and hoist her anchor ball ;
- (ii) by night display only her riding light ;
- (iii) on the near approach of another vessel sound one long blast followed by two short blasts.
- (iv) in low visibility sound one long blast followed by two short blasts at intervals not exceeding one minute.

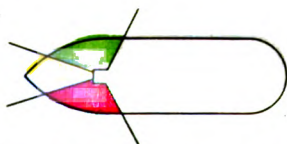
In low visibility, by day or night, a fishing vessel of 20 tons gross tonnage and upwards, when engaged in fishing, makes the following sound signals at intervals not exceeding one minute:— one blast on the siren or foghorn followed by the ringing of a bell, or a blast consisting of a series of several alternate notes of higher and lower pitch.

A vessel of under 40 tons gross tonnage need not make these signals, but must make some efficient sound signal at intervals not exceeding one minute.

In low visibility and when not engaged in fishing, fishing vessels sound the normal signals for their type of vessel.



A steam trawler trawling, at night.



Arcs of visibility of a steam trawler's tricolour lantern.

A steam trawler engaged in trawling at night carries the following lights instead of the normal navigation lights :—

in place of her fore steaming light, a tricolour lantern, showing a white light from right ahead to two points on each bow, and a red light and a green light showing from two points on the bow to two points abaft the beam, on the port and starboard sides respectively ; below this combined lantern she carries an all-round white light, and she also carries an overtaking light.

A sailing trawler engaged in trawling at night carries an all-round white light at her masthead, and should show a white flare on the approach of another vessel.

Vessels should not pass close astern of a trawler when she is trawling.



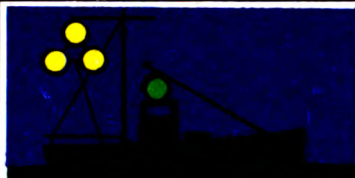
A vessel fishing under way by night, with gear extending from her 500 feet or less. The lower light indicates the direction of her gear from the upper light.

A vessel under way by night and fishing with nets or lines extending 500 feet or less displays an all-round white light and, on approaching or being approached by another vessel, displays a second white light below the first and in the direction from it of her gear.

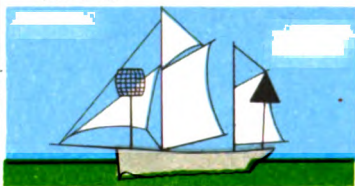
If fishing at anchor she displays :—

- (i) by night an all-round white light below her riding light and in such a position that a line from her riding light through her white light points in the direction of her gear.
- (ii) by day her basket in such a position that a line from her anchor ball through her basket points in the direction of her gear.

LIGHTS, DAYMARKS AND FOG SIGNALS OF VESSELS



A vessel fishing under way, by night, and making way, with gear extending from her more than 500 feet.



A vessel fishing under way, by day, with gear extending from her more than 500 feet.

A vessel under way and fishing with nets or lines extending more than 500 feet displays :—

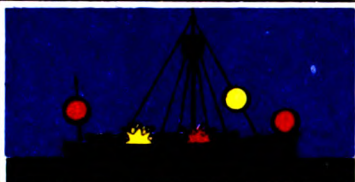
(i) by night three all-round white lights in the form of a triangle apex upwards. If she is making way she shows in addition her side-lights ;

(ii) by day her basket above her stem and also a black cone, apex upwards, where it can best be seen.

If fishing at anchor, she displays :—

(i) by night, in addition to her riding light and three white lights, an all-round white light below her riding light and in the direction from it of her gear ;

(ii) by day, in addition to her anchor ball and cone, her basket in the direction from her anchor ball of her gear.



A light vessel out of position, at anchor, at night.*



A light vessel out of position, by day.*

A light vessel not in her proper position at night* dowses her main light and carries an all-round red light at each end. In addition she burns a red and a white flare, simultaneously, every fifteen minutes ; if she cannot burn flares she shows a red and a white light instead. If anchored she carries her riding light, and if under way she shows her side-lights.

By day, a light vessel not in her proper position* hoists a black ball at each end and flies the International Code Signal *PC*. In addition, her daymark is lowered if practicable.

In low visibility, a light vessel not in her proper position sounds the normal signals for a vessel under way or at anchor.



A power-driven pilot vessel under way, at night.



Pilot vessel flag.*

Any pilot vessel when engaged on her station on pilotage duty by night, whether at anchor or under way, does not display the normal navigation lights or anchor lights for a vessel of her type, but instead displays at her masthead an all-round white light visible 3 miles, and burns a white flare at intervals not exceeding 10 minutes. If making way she also displays her side-lights, but dowses them when she stops or anchors.

A power-driven pilot vessel, in addition to these lights displays below her white masthead light an all-round red light visible 3 miles.

By day a pilot vessel may fly the pilot vessel flag—a white and red horizontal flag.*

Pilot vessels not engaged on pilotage duty display the normal lights and shapes prescribed for vessels of their type.

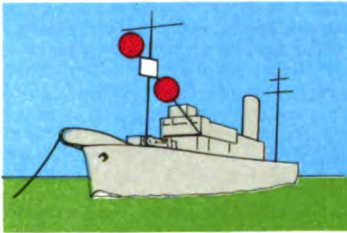
In low visibility pilot vessels sound the normal signals for vessels of their type.

*This is not a provision of the *Regulations for Preventing Collisions at Sea*.

LIGHTS, DAYMARKS AND FOG SIGNALS OF VESSELS



A cable-laying vessel making way, at night.



A cable-laying vessel, by day.

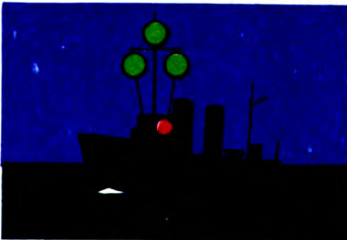
A vessel under way employed by night in laying or picking up a submarine cable or navigation marks, or a vessel engaged in surveying or underwater operations does not display steaming lights, but in place of her fore steaming light she displays two all-round red lights with an all-round white light between them, each visible for a distance of at least 2 miles. If she is making way she burns her side-lights as well.

By day she hoists two round red shapes with a white diamond shape between them.

These lights and shapes when displayed by a vessel signify that she is not under command.

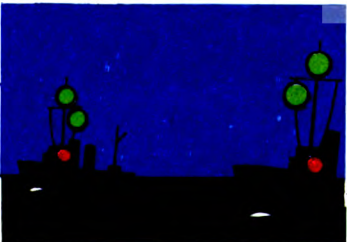
In low visibility she sounds, at intervals of not more than one minute :—

one long blast followed by two short blasts.



Sweeping vessels operating singly, at night.*

H.M. ships, operating singly or in formation, and engaged in minesweeping operations or exercises,* carry at night three all-round green lights in the form of a triangle on their foremasts, and carry their side-lights. Such vessels should not be approached within 900 yards.



Sweeping vessels towing a sweep between them, at night.*

When two vessels are towing a sweep between them at night,* each shows two all-round green lights on her foremast, in addition to her side-lights; the lower of the green lights indicates the direction of the sweep. Ships should not pass between, or cross astern within 400 yards of, two or more sweeping vessels working a sweep or sweeps.

By day sweeping vessels* carry black balls instead of the green lights.

In low visibility vessels under way with sweeps out may sound at intervals of not more than one minute :—

*one long blast followed by two short blasts.**

*Not included in the *Regulations for Preventing Collisions at Sea*, but laid down in *Admiralty Notices to Mariners*.

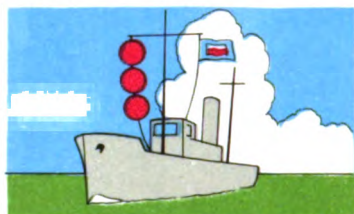
LIGHTS, DAYMARKS AND FOG SIGNALS OF VESSELS



Examination vessel's flag.*



Examination vessel at night, port open.*



Examination vessel by day, port closed.*

At British ports an Examination Service may be instituted in times of emergency. Ships arriving at the port may be met by an Examination Service vessel which flies the flag illustrated.*

If the port is open to shipping the vessel will carry no other signal by day, but by night she will carry three all-round white lights vertically from her fore yard-arm in addition to her navigation lights.*

If the port is closed to shipping the vessel will carry by day three red balls vertically from her fore yard-arm, and by night three all-round red lights in place of the balls in addition to her navigation lights.*



Seaplane, taxiing, at night.



Seaplane, more than 150 feet in length, but less than 150 feet in span, at anchor, at night.

A seaplane under way on the water by night carries:—

- (i) in the fore part amidships a white "steaming" light, visible at a distance of at least 3 miles, and showing from right ahead to 20 degrees abaft the beam on each side;
- (ii) on the starboard wing tip and port wing tip, respectively, a green and a red "side-light" visible at a distance of at least 2 miles, and showing from right ahead to 20 degrees abaft the beam on their respective sides;
- (iii) on the tail a white "overtaking" light, visible at a distance of at least 2 miles, and showing from right astern to 20 degrees abaft the beam on each side.

A seaplane at anchor by night carries:—

- (i) if less than 150 feet in length, an all-round white "riding" light visible at a distance of at least 2 miles;
- (ii) if 150 feet or more in length, an all-round white "riding" light and an all-round white "stern" light, each visible at a distance of 3 miles; and, if 150 feet or more in span, on each wing tip an all-round white light visible at a distance of at least one mile.

In low visibility a seaplane on the water is not obliged to make the sound signals of other vessels or craft, but if she does not make these signals she must make some other efficient sound signal at intervals of not more than one minute.

*Not included in the *Regulations for Preventing Collisions at Sea*, but laid down in *Admiralty Notices to Mariners*.

Signal

One prolonged blast followed by two short blasts—*cont.*

One prolonged blast followed by three short blasts

A blast consisting of a series of several alternate notes of higher and lower pitch

One blast

Two blasts

Three blasts

Any efficient sound signal other than those mentioned above

Signification

a vessel under way engaged in laying or picking up a submarine cable or a navigation mark ;

a vessel under way engaged in surveying or underwater operations, and thereby unable to manoeuvre ;

a vessel engaged in sweeping ;

a fishing vessel fast by her gear to a rock or other obstruction on the bottom.

a vessel being towed, or, if more than one are in tow, the last vessel in tow.

a vessel of 40 tons gross tonnage or more, engaged in fishing (or she may make the signal described below).

a sailing vessel under way on the starboard tack.

a sailing vessel under way on the port tack.

a sailing vessel under way with the wind abaft the beam.

a vessel of less than 20 tons gross tonnage, a rowing boat, or a seaplane on the water, which for some reason does not or cannot sound the normal signal for a craft of her type.

Signal on a Whistle, Siren or Foghorn AND on a Bell, at intervals of not more than ONE minute

Signal

One blast followed by a bell rung rapidly

Signification

a vessel of 40 tons gross tonnage or more engaged in fishing ; smaller vessels need not make this signal, but they must make some efficient sound signal at similar intervals.

Signals on a Bell AND/OR a Gong, at intervals of not more than ONE minute

Signal

a bell rung rapidly for about 5 seconds

a bell and a gong rung rapidly (but not necessarily simultaneously) for about 5 seconds

a bell rung rapidly for about 5 seconds, preceded and followed by three separate and distinct strokes on the bell

a gong rung rapidly for about 5 seconds

Signification

a vessel 350 feet in length or less, at anchor.

a vessel over 350 feet in length, at anchor.

a vessel aground.

a dredger, moored in or near a fairway, in one of H.M. dockyard ports.

Signal on a Whistle or Siren, sounded only when the need arises and at no specified interval

<i>Signal</i>	<i>Signification</i>
One short blast, followed by one prolonged blast, followed by one short blast	a vessel at anchor giving warning of her position and of the possibility of a collision to an approaching vessel ; a vessel under way* indicating to another vessel " the way is off my ship, you may feel your way past me ".

OTHER SOUND SIGNALS

Signals Authorised by the " International Code of Signals "

The sound signals in the following table may be sounded by a vessel in clear weather to attract attention, to warn other vessels, or to indicate her course of action. They should be used with discretion to avoid confusion with the more important sound signals prescribed in the *Regulations for Preventing Collisions at Sea*, and, with the exception of the first signal, their use in fog should be reduced to a minimum. The signals are those of the Morse Code, sounded on the siren or foghorn, the duration of the short and long blasts being the same as those for the sound signals described above.

<i>Signal</i>	<i>Signification</i>
R (.-.)	" The way is off my ship ; you may feel your way past me." (This is a useful signal in low visibility.)
U (.-.-)	" You are standing into danger."
V (...-)	" I require assistance."
K (-.-)	" You should stop your ship instantly."
O (- - -)	" Man overboard."
F (.-.-.)	" I am disabled ; communicate with me."
L (.-.-.)	" You should stop ; I have something important to communicate."
P (-.-.-)	" Your lights are out, or burning badly."

Signals Used in H.M. Dockyard Ports, and in some other Ports

<i>Signal</i>	<i>Signification</i>
H (...)	" Keep out of my way because I cannot keep out of yours." (This is used by ships when entering or leaving harbour to warn harbour craft to keep clear.)

* Not included in the *Regulations for Preventing Collisions at Sea*, but authorised by the *International Code of Signals*.

<i>Signal</i>	<i>Signification</i>
H E (.)	" My ship is practically stopped but turning to starboard."
H I (.)	" My ship is practically stopped but turning to port."

Signals Authorised by the International Regulations for Preventing Collisions at Sea

At least five short and rapid blasts on the whistle or siren	made by a power-driven vessel having the right of way, indicating to an approaching power-driven vessel which, by the rules, should give way : " Are you taking sufficient action to avoid a collision ? "
One prolonged blast on the whistle or siren	made by a power-driven vessel approaching a blind bend in a channel when within half-a-mile of the bend. This signal may be answered by a similar blast given by another power-driven vessel approaching the bend from the other direction.
Any detonating or efficient sound signal that cannot be mistaken for any of the authorised sound signals	made by any vessel, or a seaplane on the water, by day or night, to attract attention.

DISTRESS SIGNALS

(Authorised by Rule 31 of the " International Regulations for Preventing Collisions at Sea, 1952 ")

When a vessel or seaplane on the water is in distress and requires assistance from other vessels or from the shore, the following shall be the signals to be used or displayed by her, either together or separately, namely :—

- (a) A gun or other explosive signal fired at intervals of about a minute.
- (b) A continuous sounding with any fog-signal apparatus.
- (c) Rockets or shells, throwing red stars fired one at a time at short intervals.
- (d) A signal made by radiotelegraphy or by any other signalling method consisting of the group ••• — — — ••• in the Morse Code.
- (e) A signal sent by radiotelegraphy consisting of the spoken word " May-day ".
- (f) The International Code Signal of distress indicated by N.C.
- (g) A signal consisting of a square flag having above or below it a ball or anything resembling a ball.

- (h) Flames on the vessels (as from a burning tar barrel, oil barrel, etc.).
- (i) A rocket parachute flare showing a red light.

The use of any of the above signals, except for the purpose of indicating that a vessel or a seaplane is in distress, and the use of any signals which may be confused with any of the above signals is prohibited.

Note : A radio signal has been provided for use by vessels in distress for the purpose of actuating the auto-alarms of other vessels and thus securing attention to distress calls or messages. The signal consists of a series of twelve dashes sent in 1 minute, the duration of each dash being 4 seconds, and the duration of the interval between two consecutive dashes 1 second.

SPECIAL SIGNALS*

Fishing Vessels. A fishing vessel wishing to communicate urgent information to H.M. ships at sea hoists a fishing basket or shape over her fishing burgee or pendant.

Vessels Running Taut Wire Gear fly Flag *D*. They should not be approached within 1,000 yards.

Vessels Running Speed Trials fly Flag *A*.

British Pilot Signals. The following signals indicate that a ship requires a pilot :—

By day

- (i) International Code Flag *G*, or
- (ii) International Code Flags *P.T.*

By night

- (i) a pyrotechnic light called a "blue light", shown every 15 minutes ;
- (ii) a bright white light, flashed or shown just above the bulwarks for about one minute, at short or frequent intervals ; or
- (iii) International Code Signal *P.T.* by the Morse Code on a flash lamp.

When Searchlights Interfere with Navigation.—Any vessel approaching or under way in a British port (and also some foreign ports), where searchlights are being worked, and finding that they interfere with safe navigation, may make use of the following signals :—

- (i) *by flashing*—two long flashes, two short flashes, followed by three long flashes ;
- (ii) *by whistle, siren or foghorn*—two long blasts, two short blasts, followed by three long blasts.

Whenever possible, both the flashing and sound signals should be used, but either may be used alone.

* Not included in the *Regulations for Preventing Collisions at Sea*.

INDEX

	<i>page</i>		<i>page</i>
A.B.C.D. headquarters, for		Anchor work :	
damage control	483	Anchor watch	405
"A" sweep, for mine-		Anchoring	401-403
sweeping	441-447	Bridles :	
Abandon ship	36, 37	for securing head and stern to	
Abbreviations used in		buoys	412
communications :		for securing to a buoy	410, 411
Authorised	542, 543	Catting the anchor	410
Plain language	544	Clearing :	
Accommodation ladder	173, 174	foul anchor	404
Adapter-piece for chain cable	384	foul hawse	408, 409
Admiralty Notices to		Clearing away anchors and	
Mariners	642-644	cables	401, 402
Admiralty-pattern anchor	375	Laying out anchors by boat :	
Admiralty Tide Tables, use		heavy anchors	417-420
of	644, 657-660	light anchors	416, 417
Aircraft :		Mooring	405-407
Control surfaces and controls		Mooring swivel, use of ..	407
	475, 476	Picking-up rope, use of	411, 412
Manoeuvring on board ..	476	Pointing ship	414
Navigation lights* <i>after</i>	578, (826)	Precautions in bad weather	404, 405
Rescue	481, 482	Rigging hand capstan ..	386-388
Sea planes, attending on :		Securing :	
by day	478	head and stern to buoys	412
by night	479, 480	to a buoy	409-412
moored to a buoy	481	Securing anchors and cables :	
under way	480	after anchoring	403
Slinging	476-478	for sea	404
Stowage	476	Shortening in cable	403
Structural details	474-476	Signals used in	524, 525
Towing	480	Slipping :	
Transporting by water ..	478	from a buoy	412-413
Types	474	from a buoy astern	414
Air pumps, for diving from a		Terms and expressions used in	400, 401
boat	339	Unmooring	408
Albicore line	142, 163		
Almanac, nautical, use of	703, 704, 709		
Anchor buoy	385		
Anchor lights* .. <i>after</i>	578, (826)		
Anchor stop	385		
Anchor watch	405		
Anchoring :			
Clearing away the cables	401, 402		
Letting go the anchor ..	402		
Letting go a second anchor in			
bad weather	404		
Securing cable after anchoring	403		
Setting anchor watch ..	405		

* Figures in brackets refer to the 1948 Regulations in Appendix IV.

	<i>page</i>		<i>page</i>
Anchor work (<i>continued</i>)		Magnetic :	
Weighing :		conversion to true ..	602, 667
by deck tackle ..	413, 414	deviation	600-602
by hand capstan ..	386-388	variation ..	598-600, 602, 667
by power	403, 404	Sun's, at sunrise and sunset ..	696
Aneroid barometer	733	Beating, when sailing	289
Apothecaries fluid measure ..	763	Becket in a rope's end, how to	
Apparent Sun and time ..	697	fit	95, 96
Astern fuelling rigs, at sea 468-473		Berthing of a ship's company	
Atmosphere :		.. .. ..	78, 79
Constituents	716	Berthing hawsers :	
Humidity	718	Breast ropes	131
Pressure	716	Head and stern ropes	132
Temperature	718	Securing and casting off ..	132
Avoirdupois, table of weights 763		Springs	131, 132
Awnings :		Beaufort wind scale ..	717, 718
Awning curtains	185	Blake slip for chain cable ..	381
Care of spread awnings ..	187	Blocks :	
Furling	187, 188	Friction in, estimation of ..	226-229
Gable ends	185	Geared blocks	229-234
General care and maintenance	188	Markings on	225
Side screens	185, 186	Proof and safe lifting loads	224, 759
Small awnings	182	Strength of	224
Spreading	186	Stropping	225
Tented awnings	183-185	Testing	224
Backweight or Deadman		Boarding :	
method of working a derrick	200	A vessel at sea	328
Bale sling strop, wire rope ..	122	A wreck	329
Ballast :		Boat booms	172
Effect on stability of a ship ..	501	Boat hails, at night	557
In a boat	293, 344	Boat pulling :	
Balloons, kite, for use with		Hints to instructors	244
targets	432	Instruction in	241-244
Bands, parading of	550, 552, 554	Boat ropes :	
Barograph	734	Gangway	176
Barometers :		Lower boom	172, 248
Aneroid	733	Seaboats'	269, 270
Mercurial	731-733	Boat sailing :	
Bases, damage control ..	483	Action of the wind on the sails	
Battle-practice targets, high-		.. .. ..	283-285
speed	429-431	Beating	289
Battleships, recognition of ..	2, 10	Centre of effort of sail area ..	286
Beaching a boat	318	Drop keel, effect and use of ..	292
Bearings :		Getting under way and coming	
Fixing the ship by :		alongside	293
bearing and horizon range of		Going about	289
a light	681, 682	Heaving to	294
bearing and sounding ..	681	Man overboard	293, 294
cross bearings	677, 678	Pivoting point of a boat ..	285, 286
		Reaching	289
		Running	290
		Sea anchor, description and use	
		of	295, 296
		Set of the sails	288
		Struck by a squall, action when	291
		Swamped or capsized, action	
		when	291, 292

	<i>page</i>		<i>page</i>
Boat sailing (<i>continued</i>)		Rations for merchant ships' life-	
Terms used in	281-283	boats	370
Trim of the boat	287	Repair of	341-343
Trim of the sails and handling		Rigs	271, 275, 277-281
of the sheets	289	Sail drill	272-275, 276
Wearing	291	Sailing gear of Service boats,	
Use of the rudder	287	list of	347
Boats (<i>see also</i> Boat sailing,		Sails, care, bending, marking	
Boatwork, Life-saving		and measurement	297-300
appliances, and Power boats) :		Salutes in	557, 558
Anchors and cables	349, 350	Securing for sea (sea boats) 268-270	
Arming of	341	Searchlights for motor life-boats	
Ballast in	293, 344	of merchant ships	367
Buoyancy :		Signal book	525
of a merchant ship's lifeboat 367		Slings of	255-259, 347
of an open boat, estimation of 344		Specifications of H.M. ships' :	
test for pulling and sailing		weights, rigs, dimensions,	
boats	343, 344	ground tackle, carrying capa-	
Callsigns for	523, 525	cities	348-352
Carrying capacities :		Specification of merchant ships'	
H.M. ships	348-352	boats	366
Cutter, 32-ft., rig and sail drill		Stowage :	
275-277		H.M. ships	249-255
Davits :		Merchant ships	367-369
H.M. ships	251-253	Supply of Service boats 345, 346	
merchant ships	369	Surf boat, 27-ft., description	
Dinghy, 14-ft., description and		and rig	277, 278
rig	279, 280	Turning in a boat on radial	
Disengaging gear for sea-boats		davits	253
259-261		Whaler, 27-ft., rig and sail drill	
Distinguishing flags and pen-		271-275	
nants :		Boats' anchors and cables 349, 350	
saluting when worn by 557, 558		Boats' crutches, for stowage 249	
wearing of, in boats .. 555-557		Boats' falls :	
Distress flares for	371	H.M. ships	255
Emergency boats in merchant		Merchant ships	369
ships	366	Boats' sails (<i>see</i> Sails).	
Ensigns, wearing in	555	Boats' Signal Book	525
Equipment and fitting out of		Boats' slings :	
Service boats	346-352	Fitting slings to a Service boat 347	
Falls :		Types of boats' slings .. 255-259	
H.M. ships	255	Boatwork (<i>see also</i> Boat sailing	
merchant ships	369	and Power Boats) :	
Hailing at night	557	Anchoring	248
Hoisting and lowering :		Beaching a boat	318
at davits in harbour 261-264		Boarding :	
at davits at sea	264-266	a vessel at sea	328
boom boats	266-268	a wreck	329
merchant ships' boats 367-369		Boat pulling :	
swamped boats	266	hints to instructors	244
Indicator plates displayed in .. 556		instruction in	241-244
Life-boats in merchant ships 365-371		Carrying capacities of Service	
Life-saving capacities :		boats	348-352
merchant ships	367	Diving from a boat	338-340
Marks of respect in	557, 558	Hints to coxswains :	
Motor life-boats in merchant		of boats, generally .. 245-249	
ships	366	of sea boats	270, 271
Navigation lights*	573, (819)	Landing and going alongside .. 247	
Power boats in H.M. ships 299-317			
Radio equipment for merchant			
ships' life-boats	367		

* Figures in brackets refer to the 1948 Regulations in Appendix IV.

	<i>page</i>		<i>page</i>
Boatwork (<i>continued</i>)		Marking and stowage of	354
Landing on a rocky shore	327, 328	Small life-float	352, 361
Making fast	248	Buoyant capacity of merchant	
Sweeping by boats ..	333-338	ships' life-boats ..	366, 367
Surf, handling of boats in	319-327	Buoyant Suits	357
Torpedoes, recovery by boat	329-332	Buoyant Volume	496
Towing pulling boats ..	317, 318	Buoys :	
Bollard strops	122	Dan buoy, how to lay and lift	451-453
Boltrope	140, 161	Life-buoys	357-359
Bonnet for chain cable ..	383	Mark-buoys for sweeping, how	
Booms, for boats	172	to lay	334
Bordeaux connection, for wire		Securing ship head and stern to	
rope	145	buoys	412
Bosun's chair	180	Securing ship to a buoy	409-412
Bottom compositions :		Slipping from a buoy ..	412
Application of	516, 517	Slipping from a stern buoy	414
Types	507, 508	Buoy-securing shackle ..	384
Breathing apparatus, Pattern			
230 and Salvus	55, 60	Cable, chain, for ships'	
Bridles, chain cable :		anchors :	
For securing head and stern to		Joining shackles, lugged and	
buoys	412	lugless	376-378
For securing to a buoy	410, 411	Links in shackles of cable	379, 380
Broad pennant, Commodore's,		Markings on chain cable ..	397
wearing of	547	Parting of chain cable, disposal	
Broadcast systems for internal		of broken pieces	397
communication	63	Shackles of cable :	
Broadside messing ..	78, 79, 81	length	377
Bulkheads (<i>see</i> Water-tight		marking	378
bulkheads).		Signals displayed when working	524
Buoyancy :		Strength, weight, and stowage-	
Centre of	496	volume of chain cable ..	395
Of buoyant apparatus ..	359	Survey of chain cable ..	396
Of casks and drums ..	344, 761	Swivel pieces	378, 384
Of life-boats, merchant ships	366, 367	Table of chain cables supplied	
Of life-buoys	357	to H.M. ships	399
Of life-jackets	355	Terms and expressions used	
Of open boats	344	when working cable ..	400
Test :		Test and maintenance of chain	
for Carley life-floats ..	361	cable	395, 396
for inflatable life-rafts ..	365	Types of chain cable ..	378
for life-buoys	357	Cable gear and fittings :	
for life-jackets	355	Adapter piece	384
for pulling and sailing boats	343, 344	Anchor buoy	385
Buoyant apparatus :		Anchor strop	385
Buoyancy of	359	Blake slip	381
Carley life-float	359-361	Bonnet	383
Deck chairs and deck seats ..	359	Buoy-securing shackle ..	384
Floater-nets	365	Cable jack	385
Inflatable life-rafts :		Catting pendant	383
8-man inflatable life-rafts	352, 363	Chain hook	385
20-man inflatable life-raft	352, 363, 364	Clump cathead	383
		Compressor	383
		Hook-rope	385
		Joggle shackle	384

	<i>page</i>		<i>page</i>
Cable gear and fittings (<i>continued</i>)		Centigrade/Fahrenheit,	
Mooring swivel	384	conversion table	770
Parting stop	385	Centre of buoyancy of a ship	496
Picking-up rope	383, 384	Centre of effort of a boat's sail	
Riding slip	383	area	286
Screw slip	381	Centre of gravity, of a ship ..	496
Senhouse slip	383	Ceremonial :	
Cable holders :		Colours, wearing of ..	545, 546
Combined capstan and cable		Distinguishing flags, wearing of	
holder	393		547, 559
General description of ..	389-392	Distinguishing lights, Flag and	
Inspection and maintenance ..	396	Senior Officers ..	547, 548
Power of, and tests	395	Dressing ship	546
Cable jack	385	Gun salutes	548-551
Cafeteria messing	81	In boats	555-559
Calcium light for use with life		Military honours	550-553
buoys, description and		Piping the side	548
warning against use of ..	357	Reception procedure on board	
Callsigns, ships' and boats'	523, 525		553, 554
Canvas (<i>see also</i> Awnings, Sails,		Salutes between ships	554
and Sailmaking) :		Chain :	
Characteristics, marking, supply		Cable (<i>see</i> Cable).	
and types	198	Check stopper, for wire rope	
Repair of	191-193		130, 415
Capacity measure :		Hook, for chain cable	385
British	763	Rigging, strength of	223, 761
Metric	767	Splice, in cordage	93, 94
Capacities, carrying, of Service		Stopper, for wire rope	129
boats	348-352	Chain-hook, for cable	385
Capstans :		Characteristics, national, of	
After capstan	385, 386	warships	9-11
Combined capstan and cable-		Charts :	
holder	393	Care of at sea	683
Fore capstan	385, 386, 388	Conventional signs used on	645-648
Hand capstan, how to rig	386, 387	Corrections to	643
Inspection and maintenance ..	396	Folios for	641, 642
Power of, and tests	395	Great circle	638
Carbon tetrachloride hand fire		Indexing and grouping ..	641
extinguisher	46	Issue of	641
Carley life-floats	352, 359-361	Polar	638
Carpenter's stopper	130	Publication of	640
Carriers, aircraft, recognition		Scales of	640
of	3, 10	Types of	640
Carrying capacities of Service		Chartwork :	
boats and harbour craft	348-352	Clearing marks	675
Cash victualling	82	Compass error, checking by	
Casks :		transits	674
Buoyancy	344, 761	Courses :	
Stowage	85	laying-off and taking-off ..	667
Casualties, precautions against		shaping, allowing for tidal	
	33-35	stream	671
Cathead, clump	383	Fixing the ship :	
Catting pendant	383	by bearing and horizon range	
Catting the anchor	410	of a light	681
Celestial sphere	711	by bearing and sounding ..	681
		by cross bearings	677
		by running fix with trans-	
		ferred position line	678-681

- | | <i>page</i> | | <i>page</i> |
|---|--------------------|--|---------------|
| Chartwork (<i>continued</i>) | | Procedure for | 531-538 |
| Leading marks | 674 | Signs and phrases, used in | 531-533 |
| Plotting the ship's track | 669-671 | Compartments (<i>see</i> Watertight compartments). | |
| Position lines and fixes | 672, 677-681 | Compass : | |
| Positions of ship : | | Equipment | 603-606 |
| plotting by bearing and distance | 666 | Gyro- : | |
| plotting by latitude and longitude | 665 | compass | 583, 595 |
| reaching, allowing for tidal stream | 672 | error | 596 |
| recording of | 668 | repeaters, types of | 596 |
| transferring to another chart | 668 | steering compass | 597 |
| Siren echo, estimation of distance by | 626, 682, 769 | Magnetic : | |
| Transits | 673-676 | deviation | 600-602 |
| Chernikeyf log | 612-614 | direction, conversion to true | 602 |
| Chronometers | 706 | variation | 598-600 |
| Cinema film, fire precautions | 57 | Supply and maintenance .. | 606 |
| Cleaning ship, notes on | 519-521 | Compressor for chain cable .. | 383 |
| Clearing foul anchor | 404 | Conning and steering : | |
| Clearing foul hawse | 408, 409 | Change over of positions | 589-591 |
| Clearing marks and lines | 675, 676 | Positions | 587, 589 |
| Climate | 698, 723, 724, 729 | Precautions before proceeding to sea | 585, 586 |
| Climatic zones | 698, 729 | Special sea dutymen | 586 |
| Clocks | 706 | Steering and engine order instruments | 583-585 |
| Close stowing anchor | 377 | Steering gear | 591-594 |
| Cloud, formation of | 719 | Continuous walling, in cordage | 109 |
| Clump cathead | 383 | Conversion of weights, measures and quantities, British to metric : | |
| CO, mobile unit, fire extinguisher | 47 | Factors for : | |
| Coachwhipping | 107, 108 | approximate | 767 |
| Coastal craft, recognition of | 7 | exact | 766 |
| Coasting | 684 | Tables for : | |
| Codline | 142, 163 | Farhenheit/Centigrade | 770 |
| Coir rope | 139, 154 | linear—British/metric | 768-770 |
| Colours, wearing of | 545, 546 | Copper punts | 352 |
| Collisions at sea, regulations for preventing* | 560-581, (806-829) | Cordage (<i>see also</i> Hawsers) : | |
| Combined capstan and cable holder | 393 | Characteristics and types of | 137-140 |
| Common link of chain cable .. | 379 | Examination of, for signs of deterioration | 144 |
| Communication department, organisation | 540 | Knots and general advanced work in | 98-111 |
| Communications : | | Manufacture of | 142 |
| Abbreviations used in : | | Materials used for | 137-140 |
| authorised | 542, 543 | Net making | 110 |
| plain language | 544 | Rope : | |
| Flag signalling | 522-531 | coir | 139, 154 |
| Messages : | | hemp | 139, 154-163 |
| handling and distribution | 541, 542 | manila | 138, 154-163 |
| originating and drafting | 538-541 | nylon | 139, 140 |
| | | sisal | 138, 154-163 |
| | | Seizings | 87-91 |
| | | Small stuff : | |
| | | lines | 142, 163 |
| | | marine and nettlestuff | 142, 163 |
| | | spun yarn and houseline | 141, 142, 163 |
| | | twines | 141, 163 |

* Figures in brackets refer to the 1948 Regulations in Appendix IV.

	page		page
Cordage (<i>continued</i>)		Control and manning, organisa-	
Special types of :		tion	483, 484
boltrope	140, 161	Datum deck	28
hammock lashing	140	Emergency stations	37
hand-lead line	141, 162	Equipment :	
junk	141	duplication and dispersal of	33
log line	140, 163	rules for care and maintenance	
oakum	141	of	36
rounding	141	Flooding :	
shroud-laid rope	140, 160	precautions against	27-32
signal halyard	141, 162	Headquarters, bases and sec-	
stage lashing	140, 162	tions	483
Splicing	92-97	Identification, markings	
Stopper	128	28-29, 487-489	
Strength of, approximate	759	Miscellaneous markings	489
Tables of sizes, weights and		Machinery, duplication and dis-	
breaking stresses of	154-163	persal	33
Tackles, rove with, safe work-		Marking of pipes	492
ing load	760	Organisation	483, 484
Testing of	144	Pumps and pumping	32, 490
Worming, parcelling and ser-		Qualifying symbols	28, 29
ving	97, 98	Ship safety, general rules for	35, 36
Cordage stopper	128	Ship stability	495-505
Courses :		Shoring	493-495
Laying-off and taking-off		States of readiness	484, 485
667, 669-671		Stores, dispersal, duplication,	
Shaping, allowing for tidal		stowage	33
stream	671, 672	Unventilated compartments,	
Court martial gun	551	precautions when opening	34
C.Q.R. anchor	377	Ventilation	31, 32
Cranes :		Water-tight bulkheads, identi-	
Description	203	fication markings 27-31, 487-489	
Precautions when working	240	Water-tight compartments (<i>see</i>	
Tests	204	under W)	
Crane drivers, method of		Water-tight conditions	484, 486
giving orders to	204	Water-tight door and hatch	
Crane fuelling rig	463-467	board	486
Cringles, in canvas, how to		Water-tight fittings, rules for	
make	192, 195	care and maintenance	36
Cruisers, recognition of	4, 11	Water-tight integrity log	486
Cubic measure :		Water-tight openings (<i>see</i> under	
British	763	W)	
Metric	767	Water-tight tests, of compart-	
Cut splice	93	ments	492
Cutters, 32-ft. :		Dan buoy, how to lay and lift	
Rig and sail drill	275-277	451-453	
Specifications	348	Danforth anchor	375
Cyclones	728	Darn, sailmaker's	190, 193
Daily orders	80	Date, Greenwich, local and	
Damage Control :		zone	699-702
Abandon ship	36, 37	Date line	701
Casualties, precautions against		Datum deck	28
33-35		Davits :	
		Fixed	251, 253
		Gravity	369
		Luffing of quadrantal	251, 253, 369
		Radial	251
		Turning in a boat on radial	
		davits	253

	<i>page</i>		<i>page</i>
Day :		Distinguishing lights, Flag and Senior Officers*[†]	
Apparent and mean solar ..	696	547, 548, 575, (821)	
Stellar	712	Distress flare, for boats ..	371
Daylight and latitude ..	694	Distress signals* ..	580, (828)
Daymarks and lights displayed by ships and vessels* :		Diving from a boat :	
Examples of .. <i>after</i> 578, (826)		Air-pumps	339
Rules concerning 575-578, (821-825)		Divers : limitations and rig	338, 339
Deadman or Backweight method of working a derrick	200	Precautions	340
Deck chairs and deck seats, buoyant	359	Rigging a diving boat ..	339, 340
Deck tackle, for weighing anchor by hand	413	Shallow-water diving ..	340
Degrees of readiness	64	Doldrums	724
Derrick fuelling rig	467	Dressing lines	167
Derricks, extempore		Dressing ship	167, 546
General description	210	Drop-keel, effect and use of in a boat	292
Principles of rigging	211	Dry measure, British	763
Standing derrick, how to rig	211-213	Dutchman's log	608
Stresses in, estimation by triangle of forces	234-240	Duty watches	66, 67
Swinging derrick, how to rig	215		
Derricks, permanent :		Earth, the (<i>see also</i> Time) :	
Markings on	202	Climate	698, 723, 724, 729
Paravane	434	Orbit round the sun	690
Precautions when working ..	240	Seasons	691, 692
Rigs of	197-199	Echo, siren, estimation of distance by	626, 682, 769
Stresses in, estimation by triangle of forces	234-240	Echo-sounder, type 765 ..	629-631
Testing	202	Eddies in tidal rivers	661
Working :		Eight-man inflatable life-raft	363
deadman or backweight method, heavy lifts, and union purchase method ..	200	Electric lights, buoyant, for use with life-buoys	357
Destroyers, recognition of ..	5, 11	Emergency boats in merchant ships	366
Deviation, compass	600-602	Emergency stations	37
Diamond knots, single and double	105	End link of chain cable ..	379, 381
Dinghy, 14-ft., sailing ..	279, 280, 348	Engine-order instruments ..	585
Disengaging gear for boats ..	259-261	Engines, boats' :	
Displacement/length, warships, comparison	12, 13	Handling	313-315
Distance line, for replenishment at sea	455	Maintenance	315-317
Distance meter, Stuart's ..	618	Orders for	304
Distinguishing flags, wearing of :		Ensigns :	
Saluting when worn by boats ..	556, 558	Hoisting of when entering or leaving harbour* ..	575, (825)
Wearing of :		Wearing of :	
in boats	555, 556	in boats	555
in ships	547	in ships	545
on vehicles	559	Entering and leaving harbour, hoisting of ensigns when* ..	575, (825)

* Figures in brackets refer to the 1948 Regulations in Appendix IV.

	<i>page</i>
Equilibrium of a ship, conditions for	497
Equinoxes	693
Evening gun	551
Evolutions	70-74
Eyelets, in canvas, how to insert	195, 197
Eye-bolts	222, 223, 761
Eye-plates	222, 761
Eye splice, wire rope ..	115-117
Explosives, fire precautions	40, 53
" F " link of chain cable	379, 381
Falls, boats' :	
H.M. ships	255
Merchant ships	369
Fahrenheit/Centigrade, conversion table	770
Fenders :	
Principles of fendering ..	176
Types of fenders	177-179
Ferry harbour service craft, carrying capacities of ..	352
Fibre rope (<i>see</i> Cordage).	
Fire extinguishers, hand :	
Carbon tetrachloride, quart size	46
Gas/water	44
Two-gallon foam	45
Fire-fighting :	
Auxiliary equipment	54-56
Fire prevention	38-41
Installations :	
firemain	49, 50
flooding	53
foam inlet tubes	54
hangar spraying	54
magazine spraying	52, 53
methyl bromide	54
steam smothering	54
Methods of	56, 57
Portable appliances :	
CO ₂ mobile units	47
Foam units	46
Hand extinguishers	44-46
Portable pumps	47, 48
Principles of fire-fighting	41-43
Fire hoses	53
Firemain system	49, 50
Fires (<i>see</i> Fire-fighting).	
Fireworks, precautions ..	40

	<i>page</i>
Fishing lines :	
Albicare, cod, mackerel and whiting	141, 163
Fittings, water-tight, rules for maintenance of	36
Fixes	677-681
Fixing the ship :	
By bearing and horizon range of a light	681, 682
By bearing and sounding ..	681
By running fix with transferred position line	678-681
By cross bearings	677, 678
Flag signalling :	
Cable signals displayed when working	524
Callsigns	523, 525
Equipment	527-531
International Code	526
Making, answering and executing a signal	523
Minor landing craft and boats' signal book	525
Positions on a mast	522
Symbols used to represent flags and pennants	523
Terms used in	522
Flags :	
Colours, wearing of	545
Distinguishing :	
saluting when worn by boats	556, 558
wearing of	547, 555
Hoisted during gun salutes ..	551
Flares, distress, for use in boats	371
Flashing procedure used in naval signalling	534-537
Flat seam in sailmaking ..	190, 193
Flat seizing	87, 90
Flemish eye, in a rope's end ..	94
Float, life, Carley	352, 359-361
Floats, life, small	352, 361
Flotation, of a ship	495
Floater-nets	365
Flooding :	
Effect of	501, 502
Equipment	490
Free-surface	501
Of compartments, against fire	53
Of compartments, for stability	502
Precautions against	27-32
Pumps and pumping	490
Fluid measure, apothecaries'	763

	<i>page</i>		<i>page</i>
Forecasting of the weather,		Gold slide, for mercurial	
local	721-723	barometer	731, 732
Foam inlet tubes, against fire	54	Grafting, in cordage	107
Foam fire extinguisher, two-		Grass rope	139, 154
gallon hand	45	Gravity, centre of, of a ship ..	496
Foam units, against fire	46, 47	Gravity lowering geared block	233
Fog :		Great-circle	634
Action when entering	685	Great-circle charts	638, 639
Cause of	720	Greenwich :	
In a narrow channel, pilotage..	688	Date	701
Sound signals in* 578, (825-827)		Mean time	699
Speed in*	578, (825)	Meridian of	632
Folios for charts	641, 642	Grommets :	
Foul anchor, how to clear ..	404	In canvas	195
Foul hawse, how to clear	408, 409	In cordage	95
Free-surface liquids, effect on		Grommet strop, in wire rope	
stability	501, 502		118-120
Friction in blocks, purchases		Gross tonnage, of merchant	
and tackles, estimation of		ships, estimation of.. .. .	21
	226, 227, 229, 760	Guardrails, fitting and	
Frigates, recognition of	6	strength	167, 168
Fuelling at sea :		Guards, parading of	550-552, 554
Abeam :		Gun-salutes :	
crane fuelling rig (warship),		At funerals	549
for	463-467	Court martial gun	551
derrick fuelling rig (tanker),		Flag hoisted during	551
for	467	Logging of	551
jackstay fuelling rig (tanker),		Morning and evening gun ..	551
for	466-468	Occasions for	548
Astern :		Times of firing	549, 550
from a tanker	468-471	Gyns, extempore :	
from a warship	471-473	General description	210
Funerals, gun-salutes, at ..	549	How to rig	219
		Principles of rigging	211
Gable ends	185	Gyro- :	
Ganger, use when laying out		Compass	583, 595
bower anchor	418	Equipment for	603-606
Gangway and ladder gear ..	176	Error	596
Gas/water hand fire		Repeaters, types of	596
extinguisher	44	Steering compass	597
Geared blocks :		Supply and maintenance ..	606
General description	229	Hail, formation of	719
Gravity lowering	233	Hailing boats at night	557
Lever and ratchet	233, 234	Half hitching, in cordage ..	108
Spur geared	230	Hambroline	142, 163
Worm and wormwheel	231-233	Hammock lashing	140
General messing	80	Hand capstan, how to rig	
Glossary of terms and expressions			386, 387
used by seamen	737-758	Hand lead line	141, 162
Gnomonic projection	638, 639	Hand log	608
Going about, when sailing ..	289		

* Figures in brackets refer to the 1948 Regulations in Appendix IV.

	<i>page</i>		<i>page</i>
Hangar spraying system ..	54	Identification markings for damage control purposes	28-29, 487-489
Harbour craft, carrying capacities of	352	Indicator plates displayed in boats	556
Hard-chine power boats, handling of	311-313	Inflammable liquids, stowage and marking	84
Hawser eye	121, 122	Inflatable life-rafts :	
Hawsers :		Eight-man ..	352, 363, 365
Berthing	131-133	Twenty-man ..	352, 363-365
Bollard stops and anchor shackles for	134	Inspection (see Maintenance, Inspections and Tests).	
Handling :		Intermediate link of chain cable	379, 381
belaying	123-125	International Code of Signals	526
bending ropes to hawsers ..	123	International Regulations for Preventing Collisions at Sea, extracts from*	565-569, (810-816)
general precautions when under strain ..	123, 125-131		
Hurricane	134	Jackstay rigs for replenishment at sea :	
Laying out by boat ..	415, 416	Fuelling	466-468
Maintenance of	137	Heavy (stores) ..	462, 463
Ships' outfits of	133, 135	Light (stores and men)	458, 463
Spring hawsers	134	Joggle shackle	384
Stoppers for	128-131	Joining shackles, lugged and lugless	376-378
Stowage on reels ..	135-137	Jumping ladder	175
Surging of	127, 128	Jumping net, how to make ..	112
Survey of	137	Junk	141
Towing	420		
Headquarters, A.B.C.D. ..	483	Kelvin sounding machine	620-627
Heaving line knot	103	Kitchen rudder	310
Heaving mallet, use of ..	88	Kite balloons for use with targets	432
Heaving to in a sailing boat	294	Knots, and general work in cordage :	
Heel, of a ship	499	Coach whipping ..	107, 108
Hemp rope	139, 154-163	Continuous walling ..	109
Hong Kong or Pattern V target	426	Diamond knots, single and double ..	105
Hook-rope for chain cable ..	385	Grafting	107
Hooks, rigging	222, 761	Half hitching	108
Hoses, fire	53	Heaving line knot ..	103
Houseline	142, 163	Manrope knot	98
Humidity of atmosphere ..	718	Matthew Walker knots, single and double ..	101, 102
Hurricane hawsers	134	Monkey's fist	102
Hurricanes	728	Net making	110
Hydrants	52	Nettle or fox	106
Hydrographic publications, Admiralty :			
Charts	640-648		
Miscellaneous	644		
Notices to mariners ..	642-644		
Hygrometer	735, 736		
Identification, means of :			
Merchant ships	26		
Warships	9-11		

* Figures in brackets refer to the 1948 Regulations in Appendix IV.

- | | <i>page</i> | | <i>page</i> |
|---|--------------|---|--------------|
| Knots, and general work | | Davits for | 369 |
| in cordage (<i>continued</i>) | | Distress flares for | 371 |
| Pointing | 106 | Emergency | 366 |
| Ringbolt hitching | 109, 110 | Equipment of, general .. | 369, 370 |
| Sennet knot | 105 | Falls for | 369 |
| Six-parted crown and wall knot | | Life-saving capacity of .. | 367 |
| .. .. . | 103, 104 | Marking of | 354 |
| Stopper knot or double wall knot | 102 | Motor | 366 |
| Turk's heads, standing, running, | | Number carried in ships .. | 365 |
| multi-parted and on the bight | 99-101 | Radio equipment for | 367 |
| | | Rations for | 370 |
| | | Searchlight for | 367 |
| | | Specification of | 366 |
| | | Stowage and handling of .. | 367-369 |
|
Ladders : | |
Life-buoys : | |
| Accommodation ladder | 173, 174 | Bell code for letting go, in H.M. | |
| For life-boats in merchant ships | 369 | ships | 358 |
| Gear for | 176 | Buoyancy of | 357 |
| Jumping ladders | 175, 176 | Lights, calcium and electric, for | |
| Mediterranean ladder | 175 | use with | 358 |
| Sea gangway | 176 | Marking of | 354 |
| Land and sea breezes | 729 | Numbers carried in merchant | |
| Landing craft, recognition of .. | 8 | ships | 359 |
| Landing from a boat on a rocky | | Use of | 359 |
| shore | 327, 328 | Warning against use of calcium | |
| Landing through surf | 324 | lights with | 357 |
| Lang's lay wire rope | 145, 164 | Life-float, Carley | 352, 359-361 |
| Larne target | 426 | Life-float, small | 352, 361 |
| Latitude : | | Life-jackets : | |
| And daylight | 694 | Merchant ships : | |
| Measurement of | 633, 634 | buoyancy of | 355 |
| Laying out anchors by boat : | | marking of | 354 |
| Heavy anchors | 417-420 | numbers carried in | 355 |
| Light anchors | 416 | tests for | 355 |
| Laying out hawsers by boat | | use of | 355 |
| .. .. . | 415, 416 | H.M. ships : | |
| Lead line, hand | 141, 162 | inflatable | 356 |
| Leading marks and lines | 674-676 | standard | 355 |
| Leap year | 697 | Life-rafts, inflatable .. | 352, 361-365 |
| Length, measures of | 762, 767-770 | Life-saving appliances : | |
| Length of merchant ships, | | Buoyant apparatus | 359-365 |
| estimation of | 18-20 | Classification of | 353 |
| Length/Displacement, warships, | | Equipment of | 354 |
| comparison of | 12, 13 | Life-boats, merchant ships' .. | 365-371 |
| Lever and ratchet purchase | | Life-buoys | 357-359 |
| .. .. . | 233, 234 | Life-jackets and buoyant suits | |
| Life-belts, inflatable | 357 | .. .. . | 355, 356 |
| Lifeboatmen, certificated, for | | Marking of | 354 |
| merchant ships' lifeboats .. | 371 | Miscellaneous equipment : dis- | |
| Life-boats, merchant ships' : | | stress flares, line-throwing ap- | |
| Buoyant capacity of | 367 | pliances and scramble nets .. | 371 |
| Certificated lifeboatmen for .. | 371 | Rocket life-saving apparatus | |
| Classification of | 366 | .. .. . | 372, 373 |
| | | Specification and survey of .. | 353, 354 |
| | | Stowage of | 354 |
| | | Life-saving capacities of | |
| | | lifeboats | 367 |

	<i>page</i>		<i>page</i>
Lights :		Machinery :	
Displayed by ships and vessels		Boats :	
(<i>see Daymarks and Lights</i>).		handling	313-315
Distinguishing, Flag and Senior		maintenance	315-317
Officer's*	547, 575, (821)	Ships', duplication and dispersal	
Navigation (<i>see Navigation</i>		for damage control purposes	33
lights).		Mackerel line	142, 163
Single white, notes on sighting*		Magazine spraying system	
574, (821)		against fire	52, 53
Line-throwing appliances in		Magnetic compass :	
ships	371	Deviation	600-602
Linear measure :		Direction, conversion to true ..	602
British	762	Variation	598-600
Metric	767	Magnetism	597, 598
Lines, cordage :		Maintenance, Care, Inspection,	
Fishing lines	142, 163	Surveys and Tests of	
Hambroline	142, 163	Equipment :	
Lead line, hand	141, 162	Anchors	395-397
Log line	140, 163, 610	Awnings	187, 188
Roundline	142	Blocks	224
White line	142, 163	Boats' buoyancy, H.M. ships ..	343
Links of chain cable, common,		Cables, chain	395, 396
end, "F", and intermediate		Capstans, cable holders and	
379, 380		windlasses	395
Liquid measure, British ..	763	Carley life-floats	361
List, of a ship :		Compasses	606
Definition of	499	Compartments, for water-tight-	
Effect on fighting efficiency ..	504	ness	492
Effect on stability of	500	Cordage	144
Correction of	502	Cranes	204
Loading, of a ship :		Damage control equipment ..	36
Effect on stability of	499	Derricks	202
Off-centre, effect of	500	Fire-fighting appliances ..	44-46
Local Mean Time	699	Hawsers	137
Log line	140, 163, 610	Inflatable life-rafts	365
Logging of gun-salutes	551	Life-boats	354
Logs :		Life-buoys	357
Chernikeef	612-614	Life-jackets	355
Dutchman's	608	Paint brushes	511, 512
Hand	608	Rigging	220-229, 518
Pitometer	614-617	Ship, generally	517-521
Ship's	687, 688	Slings	209
Towed (Trident)	610-613	Spray-gun for paint	515, 516
Loll, of a ship :		Telemotor steering gear ..	593, 594
Effect on stability of	502	Wire rope	150-152
Reduction of	504	Man overboard, from a sailing	
Longitude :		boat	293, 294
Measurement of	633, 634	Manila rope	138, 154-163
Time, conversion into	697, 698	Manrope knot	98
Long splice :		Mapping :	
Cordage	92	Gnomonic projection	638, 639
Wire rope	114	Mercator's projection	635-638
Low Visibility (<i>see Fog</i>).		Stars	713-715
Lower booms, for boats	172	Marks of respect (<i>see Salutes</i>).	
Lugged and lugless joining		Marline	142, 163
shackles	376-378	Masts (<i>see Topmasts</i>).	

* Figures in brackets refer to the 1948 Regulations in Appendix IV.

- | | <i>page</i> | | <i>page</i> |
|--|-------------|---|---------------|
| Matthew Walker knots, single and double | 101, 102 | Dan buoys, laying and lifting | 451-453 |
| Mean Sun and mean time .. | 697 | “ Influence ” and “ Moored ” .. | 441 |
| Measures (<i>see</i> Weights and measures). | | Oropesa or “ O ” sweep .. | 447, 448 |
| Mediterranean ladder .. | 175 | Two-speed sweep .. | 449, 450 |
| Mercator's projection .. | 635-638 | Minor landing craft and boats' signal book | 525 |
| Merchant ships : | | Mist, cause of | 720 |
| Gross tonnage, estimation of .. | 21 | Modified general messing .. | 80 |
| Identification, means of .. | 26 | Monkey-face or union plate .. | 223 |
| Length, estimation of .. | 18-20 | Monkey's fist knot | 102 |
| Life-saving appliances for .. | 353-373 | Monsoons—North-east, North-west and South-west | 725 |
| Recognition of .. | 14-26 | Month, explanation of its period | 697 |
| Mercurial barometer : | | Moon : | |
| Description | 731 | Appearance and attitude of .. | 652, 708 |
| Gold slide for correction of readings | 732 | Influence on tides of .. | 649, 652 |
| How to read | 732 | Orbit round the Earth of .. | 707 |
| Meridians | 632 | Phases of .. | 652, 707, 708 |
| Messages : | | Rising and setting of .. | 709 |
| Handling and distribution .. | 541-542 | Moored targets | 432 |
| Originating and drafting .. | 538-541 | Mooring ship : | |
| Messenger duties | 58 | Dropping moor | 405, 407 |
| Messing : | | Inserting the mooring swivel .. | 407 |
| Cafeteria and broadside .. | 81 | Running moor | 406 |
| Cash victualling | 82 | Mooring swivel | 384, 407 |
| General messing | 80 | Morning and evening gun .. | 551 |
| Modified general messing .. | 80 | Motor life-boats in merchant ships : | |
| Victualling allowance | 81 | Classification | 366 |
| Meteorological instruments : | | Number carried | 366 |
| Barograph | 734 | Radio equipment for | 367 |
| Barometers : | | Searchlights for | 367 |
| aneroid | 733 | Musters of the hands, watches, parts, etc. | 63 |
| mercurial | 731-733 | Narrow waters, pilotage in .. | 687 |
| Gold slide, for mercurial barometer | 732 | Nautical Almanac, use of for finding : | |
| Hygrometer | 735, 736 | Standard time | 703 |
| Thermometers : | | Times of : | |
| sea | 734 | moonrise and moonset .. | 709 |
| wet and dry bulb | 735 | sunrise and sunset .. | 703, 704 |
| Methyl-bromide fire extinguishers | 54 | twilight | 704 |
| Metric system (<i>see</i> Weights and measures). | | Naval stores | 83 |
| Military honours : | | Navigation lights* : | |
| Examples of | 550 | General notes on .. | 573, (819) |
| Guards and bands | 551, 552 | Of a sailing vessel .. | 572, (819) |
| Notes on | 552 | Of a small boat under oars or sail | 573, (819) |
| Minesweepers : | | | |
| Lights carried by* <i>after</i> 578, (826) | | | |
| Recognition of | 7 | | |
| Mines, types of | 433, 441 | | |
| Minesweeping : | | | |
| “ A ” sweep | 441-447 | | |
| Comparison of “ A ” and “ O ” sweeps | 448 | | |

* Figures in brackets refer to the 1948 Regulations in Appendix IV.

	<i>page</i>		<i>page</i>
Navigation lights* (<i>continued</i>)		Watch duties at sea ..	69, 70
Of a steam vessel :		Watch duties in harbour ..	67, 68
over 150 ft. in length..	572, (818)	Watchkeepers	78
of under 40 tons gross tonnage		Watchkeeping roster ..	67
	572, (819)	Orion, constellation of ..	715
Sighting, notes on ..	574, (820)	Oropesa or "O" sweep ..	447, 448
Single white light, significations		Overtaking Light* ..	572, (818)
on sighting	574, (821)		
Neap tides	651, 652		
Nets :		Packing weights and quantities ..	764
Cordage provision net, how to		Paint :	
make	110	Brushes, types and care of ..	511, 512
Floater-net	365	Coats, composition of, and	
Jumping net, how to make ..	112	schemes for	506
Scramble net	371	Mixing	508
Wire rope provision net, how		Spray-gun for	514
to make	111, 112	Types of	507, 508
Nettle or Fox	106	Painting :	
Nettlestuff	142, 163	By brush	511-513
Night sky, appearance of ..	712	By spray gun	513-516
Northern pointers (to Pole		In general	510
Star)	714	The ship's bottom	516
Notices to Mariners,		Preparation of a surface for ..	509
Admiralty	642-644	Parallels of latitude	632
Nylon rope	139, 140	Paravanes :	
		Description	433-435
Oakum	141	Gear and rig for running ..	435-437
Offices	79, 80	Recovering	438
Oil, petrol, water—comparative		Rigs	435-437, 440
weights, volumes, etc. ..	765	Running, notes on ..	439, 440
Orbit :		Streaming	437, 438
Of the Earth round the Sun ..	690	Parcelling, serving and worming	
Of the Moon round the Earth..	707	of rope	97, 98
Organisation :		Parting strop for chain cable ..	385
Berthing of ship's company ..	78, 79	Patterns II, V and VII targets ..	426-428
Daily orders	80	Pennants, wearing of in boats ..	555
Damage control	483, 484	Petrol and oil fires, methods	
Degrees of readiness	64	of extinguishing	56, 57
Duty watches	66, 67	Petrol, oil, water—comparative	
Evolutions	70-74	weights, volumes, etc. ..	765
Messing	78, 80, 81	Petty officers, routine and	
Musters	63	special duties of	74, 75
Offices	79, 80	Phases of the Moon ..	652, 707, 708
Petty officer's routine and		Phrases and signs used in	
special duties	74, 75	naval signalling	531, 532
Quarters	65	Picking-up rope :	
Quarters organisation of a des-		Description	383, 384
troyer	64	Use	411, 412
Special dutymen and special		Pilotage (see also Rule of the	
parties.. ..	75-78	Road) :	
Special sea dutymen	77	Coasting	684
States of readiness, damage		Charts, care of at sea	683
control	484, 485	Fog and thick weather.. ..	685
Station bill	70	Narrow waters	687
Watch and station bill..	65, 66	Preparation for a passage ..	683
		Ship's log	688

* Figures in brackets refer to the 1948 Regulations in Appendix IV.

	<i>page</i>		<i>page</i>
Pipes, colour markings	.. 492	Provisions :	
Piping the side	548	Casks, stowage of	85
Pitometer log :		Extra issues	82
Type D.	616, 617	Methods of packing	83
Type M.A.3	615-617	On repayment	82
Pivoting point of a sailing boat		Preparing for provisioning	85
	285, 286	Routine for issues	82
Planets	709, 710	Stocks maintained on board	82
Plotting :		Stowage	84
Positions :		Pumps and pumping ..	32, 490
by bearing and distance ..	666	Punts, copper	352
by latitude and longitude ..	665	Purchases and tackles :	
The ship's track	669-671	Deck-tackle, for weighing an-	
Pointing, in cordage	106	chor	413
Pointing ship	414	Friction in, estimation of ..	226, 229
Polar charts	638, 639	Mechanical advantage of ..	229
Pole star and how to find it	714	Reeving a three-fold and a two-	
Portable pumps :		fold purchase	228
Fire	47, 48	Safe working loads of ..	227, 760
Flooding	490	Special purchases, estimation of	
Position lines and fixes		friction in	229
	672, 677-681	Quadrantal, or luffing, davits	
Position :			251, 253, 369
Plotting by bearing and distance	666	Qualifying symbols, on water-	
Plotting by latitude and longi-		tight openings	28, 29
tude	665	Quarters	65
Reaching, allowing for tidal		Quarters organisation of a	
stream	671, 672	destroyer	64
Recording of	633, 668	Questions, typical of those	
Transferring to another chart ..	668	asked in examinations	771-805
Power Boats :		Racking seizing	87, 91
Carrying capacities of	351	Rain, formation of	719
Engines :		Rafts, life, inflatable	352, 361-365
handling of	313-315	Rat-guards, on berthing	
maintenance of	315-317	hawser	133
orders for	304	Rattling down shrouds ..	168
Handling generally	299-305	Reaching, when sailing ..	289
Hard-chine boats, handling of :		Recognition (see Ship recognition).	
generally	311, 312	Reduced eye, in wire rope ..	120
single-screw	312	Reels, hawser	135-137
twin and triple screw ..	312, 313	Repair of boats :	
Particulars of	350	Emergency	341
Round-bilge boats, handling of :		Semi-permanent	343
single-screw	305-308	Temporary	341
single-screw with Kitchen		Replenishment at sea :	
rudder	309, 310	Distance line, for	455
twin-screw	308	Fuelling abeam :	
Preformed wire rope	145	crane fuelling rig	463-467
Pressure systems of the		derrick fuelling rig	467
atmosphere	716, 720	jackstay fuelling rig ..	466-468
Procedure signs and phrases		Fuelling astern :	
used in naval signalling	531-533	from a tanker	468-471
Projections :		from a warship	471-473
Gnomonic	638, 639		
Mercator's	635-638		
Propeller boards	133		
Provision nets, how to make :			
Cordage	110		
Wire rope	111, 112		

	page		page
Replenishment at sea (<i>continued</i>)		Rigging fittings, sizes and strengths :	
Jackstay rigs for stores and men :		Chain	223, 761
heavy	462, 463	Eyebolts	222, 223, 761
light	458-463	Eyeplates	222, 761
Methods of	454-457	Hooks	222, 761
Revolutions, estimation of		Rigging screws	223
speed by	610	Ringbolts	223, 761
Rhumb line	635	Rings	223, 761
Riding light*	after 578, (826)	Shackles	221, 761
Riding slip for chain cable ..	383	Slips for rigging	224
Rigging :		Thimbles	121, 195, 221
Awnings	182-188	Union plates, shamrock plates, or monkey-faces	223
Blocks :		Rigging screw	223
geared	229-234	Rigging warrant	167
for purchases and tackles, proof and safe lifting load	224	Righting lever and righting moment for ship stability ..	498
stopping	225	Rigs for Service Boats :	
Boat-booms	172	Cutter, 32-ft.	275
Cranes	203, 204	Dinghy, 14-ft.	279-281
Derricks :		Surf boat, 27-ft.	277-279
extempore	210-215	Whaler, 27-ft.	271, 272
permanent	197-202	Ringbolts	223, 761
Dressing lines	167	Ringbolt hitching	109, 110
Fenders	176-179	Rings, for rigging	223, 761
Fittings and gear, strength of, and proof and working loads of	220-229, 761	Robinson's disengaging gear, for seaboats	259-261
Gangway and ladder gear ..	176	Rocket life-saving apparatus :	
Guardrails	167	Details and operation of ..	372
Gyns, extempore	210-219	Signals used with	373
Ladders	173-176	Stations	372
Purchases and tackles ..	226-229	Roll, period of	499
Rattling down	168	Roman numerals	769
Rigging warrant	167	Rope (<i>see</i> Cordage, Hawser and Wire Rope).	
Rigs of boats	271-281	Roping, of canvas	194
Safe working loads of :		Roping twine	141, 163
blocks	224	Round-bilge power boats, handling of	305-310
common fittings	220-224, 761	Rounding	141
purchases and tackles ..	227, 760	Roundline	142
slings	209, 759	Round seam, in sailmaking	
spars	211, 761	.. .. .	190, 193
Sailmaking	188-197	Round seizing	87, 90
Sheers extempore	210-219	Rudder, use of :	
Slinging	205-209	In power boats	301
Spars :		In sailing boats	287
repairing	181, 182	Rule of the Road* :	
strength of	211, 761	Day marks and lights exhibited by vessels, particulars and illustrations of, with their fog signals	after 578, (826)
Stages	179-181	Rules concerning day marks and lights	575-578, (821-825)
Stresses in derricks, estimation of by triangle of forces	234-240	Distress signals	580, (828)
Tackles and purchases ..	226-229		
Topmasts :			
housing a telescopic topmast			
.. .. .	171, 172		
striking a fidded topmast ..	171		
Winches	202		
Yards :			
crossing a slung yard to a mast	171		
sending down a slung yard ..	168		

* Figures in brackets refer to the 1948 Regulations in Appendix IV.

	<i>page</i>		<i>page</i>
Rule of the Road* (<i>continued</i>)		Sewing :	
<i>International Regulations for</i>		flat seam	190, 193
<i>Preventing Collisions at Sea</i>		patching a hole	193
articles 16 to 30 inclusive		round seam	190, 193
564-569, (810-816)		sailmaker's darn	190, 193
Miscellaneous signals made by		Splices	194
ships and vessels .. 581, (829)		Thimbles, how to insert in	
Navigation lights		cringles	195
571-575, (818-821)		Tools	190-192
Sound signals :		Sails, of boats :	
avoiding collision, for 571, (817)		Action of wind on	283-285
distress	580, (828)	Bending to a spar	297, 298
low visibility, in 578, (825-826)		Care of	296
miscellaneous 579-580, (827-828)		Centre of effort of sail area	286
Steering and sailing rules :		Marking	298
articles 17 to 27 verbatim		Measurement	299, 300
565-568, (810-815)		Particulars of	348
definitions of terms used in		Set of	288
563, (809)		Trim of, and handling of sheets	289
general principles of		Salutes and marks of respect :	
561-564, (807-810)		Between ships	554
giving way vessel, for 563, (809)		By gun	548-551
remarks on	570, (816)	During ceremonial reception on	
risk of collision, in .. 562, (808)		board	553, 554
Running, when sailing .. 290		In boats	557, 558
		Military honours	551-553
		To standards and distinguishing	
		flags worn by boats .. 556, 557	
		Scramble nets	371
		Screw, rigging	223
		Screw slip for chain cable .. 381	
		Sea anchor for boats, description	
		and use of	295, 296
		Sea and land breezes	729
		Seaboats :	
Safe working loads :		Davit equipment	251
Blocks	224, 759	Disengaging gear	259-261
Chain :		Hints to coxswains of	270
cable	395	Hoisting and lowering	264-266
rigging	223, 761	Securing for sea	268-270
Cordage	759	Sea gangway	176
Common rigging fittings		Sea measures	608
220-229, 761		Seams, in canvas :	
Purchases and tackles .. 227, 760		Flat, and round	190, 193
Slings	209, 759	Seaming twine	141, 163
Spars	211, 761	Seaplanes, attending on by	
Wire rope	759	boat :	
Safety lamp, use when opening		By day	478
unventilated compartments 34		By night	479, 480
Sail drill for Service boats :		Moored to a buoy	481
Cutter, 32-ft.	276	Under way	480
Whaler, 27-ft.	272	Searchlights :	
Sailing (<i>see</i> Boat sailing).		For merchant ships' lifeboats .. 367	
Sailing terms, definitions of		When interfering with naviga-	
281-283		tion, signal for* .. 581, (829)	
Sailing vessels, navigation		Seasons	691, 692
lights for*	572, (819)	Sections, damage control .. 483	
Sailmaking :			
Canvas, characteristics, mark-			
ing, supply and types .. 188			
Cringles, how to make .. 192, 195			
Eyelets, how to insert .. 195, 197			
Grommets	195		
Roping	194		

* Figures in brackets refer to the 1948 Regulations in Appendix IV.

	<i>page</i>		<i>page</i>
Securing a sea boat for sea	268-270	Equilibrium, conditions for	.. 497
Securing anchors and cables for sea	 404	Flotation	 495
Securing cable after anchoring	403	Flooding :	
Securing head and stern to buoys	 412	effect of	 501, 502
Securing to a buoy	.. 409-412	free-surface	 501
Seine twine	 141, 163	Heel :	
Selzings :		definition of	 499
Cordage :		List :	
flat	 87, 90	definition of	 499
round	 87, 90	effect on fighting efficiency	.. 504
racking	 87, 91	effect on stability	.. 500, 504
Wire rope	 121, 122	correction of	 502
Semaphore, procedure in naval signalling	 537, 538	Loading :	
Senhouse slip for chain cable	383	effect of	 499
Sennet knot	 105	off-centre	 500
Serving, worming and parcel-ling of rope	.. 97, 98, 122	Loll :	
Shackles :		description of	 502
Buoy-securing	 384	reduction of	 504
Joggle	 384	Righting lever	 498
Joining, lugged and lugless	376-378	Righting moment	 498
Rigging, size and strength	221, 761	Roll, period of	 499
Shackles of cable :		Topweight	 501
Length	 377	Trim :	
Marking	 378	definition of	 499
Shallow-water diving from a boat	 340	effect on fighting efficiency of	504
Shamrock or union plate	.. 223	Shoe links, for wire ropes	.. 146
Sheaves, used with wire rope	147-149, 759	Shoring bulkheads, decks, hatches and water-tight doors	 493-495
Sheers, extempore :		Short splice, in wire rope	113, 114
General description of	 210	Shortening in cable	.. 400, 403
How to rig	 215-219	Shroud-laid rope	.. 140, 160
Principles of rigging	 211	Side-lights*	 572, (818)
Strength of spars for sheer legs	211, 761	Side screens	 185, 186
Stresses in, estimation of by triangle of forces	.. 234-240	Signal halyard	 141, 162
Ship maintenance, general	517-521	Signalling procedure :	
Ship recognition :		Flashing	 534-536
Of merchant ships	.. 14-26	Semaphore	 537, 538
Of warships	 1-13	Signs and phrases used in	531-533
Ship's log	 688	Voice	 533, 534
Ship safety (see also Damage control) :	 27-37	Signals	
Maintenance of fittings and equipment for	 36	(see also Communications) :	
General rules for	 35	Distress*	 580, (828)
Ship stability :		Distress flares	 371
Ballast	 501	Miscellaneous, displayed or made by ships and vessels*	575-578, 581, (821-825, 829)
Buoyant volume	 496	Rocket life-saving apparatus, for use with	 373
Centres of gravity and buoyancy	496	Sound, for avoiding collision, and in low visibility (see Sound signals).	
Degree of	 499	When working cables	 524
		Signs and phrases used in naval communications	531, 532
		Signs, conventional, used on charts	 645-648

* Figures in brackets refer to the 1948 Regulations in Appendix IV.

	<i>page</i>		<i>page</i>
Siren echo, estimation of		Splicing :	
distance by ..	626, 682, 769	Cordage :	
Sisal rope ..	138, 154-163	chain splice ..	93, 94
Six-parted crown and wall		cut splice ..	93
knot	103, 104	fitting a becket ..	95, 96
Slinging (see also Boats' slings) :		Flemish eye ..	94
Aircraft	476-478	grommet ..	95
Code of hand signals for ..	204	into wire rope ..	122
Generally	205-208	long splice ..	92
Working loads of slings, esti-		sailmaker's ..	194
mation of	209, 759	Wire rope :	
Slip for rigging..	224	bale sling strop ..	122
Slipping by the stern from a		bollard strop ..	122
buoy	414	breaking in a rope round a	
Slipping from a buoy ..	412	thimble ..	116, 117
Slips for chain cable (see		eye splice ..	115-117
Stoppers).		grommet strop ..	118-120
Small stuff, cordage :		hawser eye ..	121, 122
Lines :		long splice ..	114
fishing—albicore, cod, mack-		reduced eye ..	120
erel and whiting ..	142, 163	seizing and serving ..	122
hambroline	142, 163	short splice ..	113, 114
roundline	142	with cordage ..	122
whiteline	142, 163	Spray-gun, for painting ..	514
Marline and nettlestuff ..	142, 163	Spring hawsers ..	134
Spunyarn and houseline ..	141, 163	Spring tides ..	651, 652
Twines : roping, seaming, and		Springs (berthing hawsers)	
seine	141, 163		131, 132
Snow, formation of ..	719	Spunyarn ..	88, 141, 163
Sockets for wire rope ..	146	Spur-gearred blocks ..	230
Solar system, the :		Square measure :	
Earth and the Sun ..	690-696	British	762
Moon	707-709	Metric	767
Planets	709, 710	Stability (see Ship stability).	
Solids, mensuration of ..	765	Stage lashing ..	140, 162
Solstices	693	Stages :	
Sound, speed of ..	626, 682, 769	Bosun's chair :	
Sound signals* :		on a gantline ..	178, 180
Avoiding collision, for		on a stay ..	181
568, 571, (815, 817)		Funnel	181
Distress	580, (828)	Plank	179-180
Fog and low visibility, in		Standard time ..	703
578, (825, 826)		Stars :	
Miscellaneous ..	579, 580, (827-828)	Celestial sphere ..	711
Sounding :		Grouping and naming of ..	713
Echo sounding	626-631	Map of, description and how to	
Machine sounding	620-627	use ..	713, 714, after 538
Southern pointers,		Night sky, appearance of ..	712
constellations	715	Northern pointers, the ..	714
Spanish windlass, use of ..	89	Orion, constellation of ..	715
Spars :		Pole star, the ..	714
Repairing	181	Southern pointers, the ..	715
Strength of	211, 761	Stellar day and year ..	712
Special dutymen and special		States of readiness, damage	
parties	75-78	control	484, 485
Special sea dutymen ..	77, 586	Station bill ..	70
Speed and depth table, for use		Steam smothering of fire ..	54
when sounding by machine	627		

* Figures in brackets refer to the 1948 Regulations in Appendix IV.

	page		page
Steam vessels, navigation		Stresses in derricks and	
lights for* :		sheers, estimation of by	
Over 150 ft. in length ..	572, (818)	triangle of forces ..	234-240
Under 40 tons gross tonnage		Strops in wire rope :	
..	572, (819)	Bale sling	122
Steaming lights* ..	572, (818)	Bollard	122
Steering (<i>see</i> Conning and		Grommet	118-120
Steering).		Stuart's distance meter	618
Steering and engine order		Sun (<i>see also</i> Time) :	
instruments	583-585	Apparent	697
Steering and Sailing Rules* :		Earth's orbit round	690
Articles 17 to 27 inclusive of		Mean	697
<i>The International Regulations</i>		Sunrise and sunset :	
<i>for Preventing Collisions at</i>		Sun's bearing at	696
<i>Sea</i> ..	565-569, (810-816)	times of ..	694, 703, 704
Definitions of terms used in		Twilight :	
..	563, (809)	astronomical, civil, and nau-	
Explanation of ..	561, (807)	tical	694
Generally	570, (816)	times of, how to find ..	704
Giving way vessel, for ..	563, (809)	Sunrise and sunset :	
Risk of collision, in ..	562, (808)	Sun's bearing at	696
Steering gear in H.M. ships :		times of, how to find ..	694, 703, 704
Precaution when using ..	593, 594	Surf, handling of boats in :	
Telemotor system	591-593	Boats, suitable types for ..	321, 322
Steering positions :		Landing through surf	324
In warships	587, 589	Negotiation of surf, general	
Change over of	589-591	directions	322-324
Stellar day and year	712	Putting to sea through surf ..	325, 326
Stern light*	572, (818)	Steering in surf	322
Stockless anchors	375	Surf, general description of ..	319
Stopper knot, or double wall		Surf-riding	326
knot	102	Surf boat, 27-ft., description	
Stoppers :		and rig	277, 278, 348
Blake slip, for chain cable ..	381	Surfaces, mensuration of ..	765
Carpenters, for wire hawsers		Surging of hawsers	127, 128
and rope	130	Surveys of equipment (<i>see</i>	
Chain, for wire hawsers and rope	129	Maintenance).	
Chain check, for wire hawsers		Swaged terminals for wire	
and rope	130	ropes	146
Cordage, for cordage hawsers		Sweeping by boats :	
and fibre rope	128	Against the stream	337
Riding slip, for chain cable ..	383	Mark-buoys, how to lay	334
Senhouse slip, for chain cable	383	Preparation before	333, 334
Screw slip, for chain cable ..	381	Single boat sweep	338
Stores :		Survey for, preliminary	334
Duplication, dispersal and stow-		Sweep for, component parts of	335
age of against loss or damage	33	With the stream	335, 336
Naval	83	Sweeping for Mines (<i>see</i>	
Provisions	82	Minesweeping).	
Stowage	84-86	Swifter, how to pass when	
Stowage of :		rigging hand capstan ..	387
Aircraft	476	Swivel pieces, in chain cable	
Boats of H.M. ships	249-255	..	378, 384
Casks	85		
Inflammable liquids	84		
Life-boats in merchant ships			
..	367-369		
Naval stores and provisions ..	84	Tackles (<i>see</i> Purchases and	
		tackles).	

* Figures in brackets refer to the 1948 Regulations in Appendix IV.

- | | <i>page</i> | <i>page</i> |
|---|---------------|-------------|
| Targets : | | |
| High-speed battle-practice | 429-431 | |
| Hong Kong or Pattern V | .. 426 | |
| Kite balloons for use with | .. 432 | |
| Larne | .. 426 | |
| Moored | .. 432 | |
| Pattern II | .. 428 | |
| Pattern VII | .. 427 | |
| Twin-float | .. 426 | |
| Telemotor system of steering gear | 591-594 | |
| Telephone : | | |
| How to use | 59 | |
| Systems : | | |
| damage control | 483, 484 | |
| ships | 61, 62 | |
| Temperature : | | |
| Air | 718, 734 | |
| Sea | .. 734 | |
| Terminals, for wire rope : | | |
| Bordeaux connection, shoe links, sockets, and swaged terminals | | 145, 146 |
| Terms and expressions : | | |
| Used by seamen, glossary of | | 737-758 |
| Used in anchor work | 400 | |
| Used in boat sailing | 281-283 | |
| Used in flag signalling | 522 | |
| Tests (see Maintenance). | | |
| Thermometers : | | |
| Sea | 734 | |
| Wet and dry bulb | 735, 736 | |
| Thimbles | 121, 195, 221 | |
| Tidal streams : | | |
| Description of | 660 | |
| Eddies in | 661 | |
| Forecasting | 663, 664 | |
| In harbours | 661 | |
| In rivers | 661 | |
| Indication on charts of | 662 | |
| Information on | 662 | |
| Turbulence | 661 | |
| Weather-going | 661 | |
| Tide Tables, Admiralty, use of | 657-660 | |
| Tides : | | |
| Causes of | 649 | |
| Ebb | 653 | |
| Flood | 653 | |
| Information regarding, on | | |
| charts | 658 | |
| Interval between | 653 | |
| Local | 653 | |
| Moon—influence of the Moon on | | 649 |
| Neap | 651, 652 | |
| Range of | 653 | |
| Stand of | 653 | |
| Spring | 651, 652 | |
| Tidal definitions | 654 | |
| Tide Tables, Admiralty | | 657-660 |
| Wave | 649, 650 | |
| Weather, effect on tides of the | | 653 |
| Time : | | |
| Apparent | 697 | |
| Chronometers and clocks | 706 | |
| Date : conversion from Greenwich to local and vice versa | | 699-703 |
| line, the | 699-701 | |
| Day, the : | | |
| apparent and mean solar | 696 | |
| stellar | 712 | |
| Greenwich mean | 699-701 | |
| Local mean | 699-701 | |
| Longitude and comparison | | 697, 698 |
| Kept on board | 706 | |
| Mean | 697 | |
| Month, the | 697 | |
| Standard | 703 | |
| Sunrise and sunset, of | 703, 704 | |
| Twilight, of | 694, 704 | |
| Watches | 706 | |
| Year | 697 | |
| Zone | 701-703 | |
| Time/Zone chart | 700 | |
| Tingle for repairing a boat, how to put on | 341 | |
| Tonnage, gross, of merchant ships, estimation of.. | 21 | |
| Topmasts : | | |
| Housing a telescopic topmast | | 171, 172 |
| Striking a fiddled topmast | 171 | |
| Top-weight, effect on ship stability | 501 | |
| Torpedo boats, recognition of | 7 | |
| Torpedoes, recovery by boat | 329-332 | |
| Towed log (Trident) | 610-613 | |
| Towing : | | |
| Aircraft | 480 | |
| Arrangements in warships | | 421, 422 |
| Hawsers for | 420 | |
| By power boat | 304 | |
| Pulling boats | 317, 318 | |
| Slipping the tow | 425 | |
| Taking a ship in tow | 421-424 | |
| Targets : | | |
| high-speed battle-practice | | 429-431 |
| Hong Kong or Pattern V | 426 | |
| Larne | 426 | |
| pattern II | 428 | |
| pattern VII | 427 | |
| twin-float | 426 | |

	<i>page</i>
Trade winds—North-east and South-east	725
Trawlers, recognition of ..	7
Transits	673-676
Triangle of forces, method of, for estimating stresses	234-240
Trident log	610-613
Trim :	
Of a boat	287
Of a boat's sails	289
Of a ship :	
definition of	499
effect on fighting efficiency ..	504
Tropical storms—cyclones, hurricanes, typhoons, willy-willies	728
Turk's heads, standing, running, multi-parted, and on the bight	99-101
Twenty-man inflatable life-raft	352, 363-365
Twilight :	
Categories of	694
Times of	704
Twines :	
Roping, seaming, and seining	141, 163
Twin-float target	426
Two-gallon foam hand fire extinguisher	45
Two-speed sweep, for minesweeping	449, 450
Typhoons	728
 Union plate, shamrock plate, or monkey-face	223
Union purchase method of working a derrick	200
Unmooring ship	408
Unventilated compartments, precautions when opening ..	34
 Variables (winds)	725
Variation	598-600, 602, 667
Vehicles, wearing of distinguishing flags on ..	559
Ventilation	31, 43
Victualling :	
Allowance	81
Cash	82

	<i>page</i>
Voice communication :	
Broadcast systems	63
Messenger duties	58
Procedure used in naval communications	533, 534
Telephone :	
how to use	59
systems	61, 62, 483, 484
Voice-pipe, how to use ..	59
Warning telephone broadcast system, how to use ..	59, 60
Voice-pipe, how to use ..	59
Voice procedure used in naval signalling	533, 534
 Wa/T broadcast system ..	59, 60
Warships :	
Comparison, length / displacement	12, 13
National characteristics of ..	9-11
Recognition of	1-13
Salutes between	554
Watches for navigational use	706
Watch and station bill ..	65, 66
Watch duties :	
At sea	69, 70
In harbour	67, 68
Watchkeepers	78
Watch-keeping roster ..	67
Water, petrol, oil—comparative weights, volumes, etc. ..	765
Water-tight bulkheads :	
Identification markings	27-31, 487-489
Shoring	493-495
Water-tight compartments :	
Closing in emergency	29
Identification markings	27-30, 487-489
Orders for closing and opening	29, 486
Rules for closing and opening	29, 31
Shores and shoring	493-495
Tests for	492
Unventilated, precautions when opening	34
Water-tight conditions ..	484-486
Water-tight door and hatch board	486
Water-tight fittings, rules for care and maintenance of ..	36
Water-tight integrity log ..	486
Water-tight openings :	
Classification of	27-29
Closing of in emergency ..	29
Conditions of	484, 485
Identification markings on	27-30, 487-489

	<i>page</i>		<i>page</i>
Water-tight openings (<i>continued</i>)		White line	142, 163
Orders for closing and opening	29, 486	Whiting line	142, 163
Qualifying symbols on	.. 30	Willy-willies	728
Shoring	493-495	Winches	202
Rules for opening and closing	29, 31	Winchmen, method of giving orders to	204
Water-tight tests, of compartments	492	Wind :	
Wearing, when sailing ..	291	Beaufort wind scale ..	717, 718
Weather :		In relation to weather ..	720
Beaufort wind scale ..	717, 718	Local winds—eddies, squalls, land and sea breezes ..	728
Climate ..	698, 723, 724, 729	Local forecasting ..	721, 722
Climatic zones ..	698, 724, 729, 730	Oceanic winds—doldrums, monsoons, trade winds, variables, westerlies ..	724-728
Constituents of ..	718-720	Pressure systems, relation to ..	716, 720
Instruments ..	730-736	Tropical storms—cyclones, hurricanes, typhoons, willy-willies ..	728
Local forecasting ..	721-723	Windlasses :	
Local winds ..	728	General description of ..	393, 394
Oceanic winds ..	724-728	Inspection and maintenance of	395
Pressure systems ..	716, 720	Power of, and tests for ..	395
Tropical storms ..	728	Wire rope :	
Weighing anchor :		Bollards, size of, for ..	759
By deck tackle ..	413, 414	Factor of safety of ..	147, 148, 759
Clearing foul anchor ..	404	Fibre and wire ..	145
Clearing foul hawse ..	408	Flexibility of ..	146
Rigging capstan for weighing by hand ..	386-388	Inspection of, for signs of deterioration ..	151, 152
Securing anchors and cables for sea ..	404	Lang's lay ..	145, 164
Shortening in and weighing	403, 404	Life of ..	149
Weights and measures :		Misuse of ..	150
British :		Nets, provision and jumping, how to make ..	111, 112
apothecaries, fluid ..	763	Preformed ..	145
avoirdupois ..	763	Seizings and services ..	122
cubic ..	763	Sheaves for use with, size of ..	147-149, 759
dry ..	763	Splicing ..	112-123
lengths, miscellaneous ..	762	Strength of, approximate ..	759
linear ..	762	Strops ..	119, 122
liquid ..	763	Tables of sizes, construction, strengths, lengths and weights of all types ..	164-166
packing, weights and quantities ..	764	Terminals for ..	145, 146
solids and surfaces ..	765	Testing ..	153
square ..	762	Worming, parcelling and serving ..	97, 98
water, petrol, oil ..	765	Worm and worm wheel geared block	231
weights and quantities, miscellaneous ..	763-765	Worming, parcelling and serving, of rope ..	97, 98
Conversion of British to metric, factors for :		Yards :	
approximate ..	767	Crossing a slung yard to a mast	171
exact ..	766	Sending down a slung yard	168-170
Conversion of British to metric, tables for :		Year, period of	697
fahrenheit/centigrade ..	770	Zone time and Time/Zone chart	700, 701-703
linear ..	768-770		
Metric and British—capacity, cubic, linear, square, weight	767		
Westerlies (winds)	725		
Whaler, 27-ft. :			
Rig, and sail drill ..	348		
Specifications of ..	348		

UNIVERSITY OF CALIFORNIA LIBRARY
BERKELEY

Return to desk from which borrowed.
This book is DUE on the last date stamped below.

18 Mar '53 JF

MAR 20 1953 LU

LIBRARY USE

MAR 25 1954

4 APR '60 AR

REC'D LD

MAR 31 1960

23 Nov '62 GR

REC'D LD

NOV 14 1962

9 Sep '63 RH

LD 21-100m-7,'52 (A2528s16)476

REC'D LD

SEP 7 1963



